City of Georgetown
Georgetown Fire Station No. 7
2711 East University Avenue
GEORGETOWN, TX 78626

COG RFP No. 201812

PROJECT MANUAL
DIVISIONS 0 - 33

NOVEMBER 16, 2018
BRW PROJECT NO. 218044.00

CITY OF GEORGETOWN — **OWNER**
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ARCHITECT AND CONSULTANTS SEALS PAGE

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TECHNICAL SPECIFICATIONS

CITY OF GEORGETOWN FIRE STATION NO. 7
CONTRACT 4-2018
BRW ARCHITECTS

Robert C. Schmidt
11/16/18

Prepared by:

STRAND ASSOCIATES, INC.®
203 South Jackson Street
Brenham, TX 77833
www.strand.com

Issued for Bid
November 16, 2018

STRAND
ASSOCIATES®

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CONTRACT 4-2018
BRW ARCHITECTS

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PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 GEOTECHNICAL INVESTIGATION

A. A Geotechnical Investigation for the project site has been performed by Terracon Consultants, Inc., 5307 Industrial Oaks Boulevard, Suite 160, Austin, TX 78735. A copy of Terracon Report No. 96175283, Revision 1, dated September 21, 2018 is bound herein.

B. Log of borings indicates materials penetrated at specific locations. Owner and/or Architect assume no responsibility for any conclusions of interpretations made by Contractor related to information included in the Report. Should contractor require additional information concerning subsurface conditions, he may without cost to Owner, make additional investigations. Should additional investigations produce information different from that in Soil Report, promptly notify Owner in writing.

C. Contractor shall read and otherwise become completely familiar with contents of Soil Report, including but not limited to its recommendations for preparation of subsoil, bases, sub-bases and fill and construction of building foundations and parking surfaces in compliance with recommendations in Report. Should discrepancy be found between the requirements of Soil Report and the drawings and/or specifications, notify Owner in writing prior to beginning work.

1.03 ENVIRONMENTAL ASSESSMENT

A. A Phase I Environmental Assessment for the project site has been performed by Terracon Consultants, Inc., 5307 Industrial Oaks Boulevard, Suite 160, Austin, TX 78735. A copy of Terracon Report No. 96177607, dated October 25, 2017, is bound hererin.

1.04 GEOLOGIC ASSESSMENT

A. A Geologic Assessment for the project site has been performed by Terracon Consultants, Inc., 5307 Industrial Oaks Boulevard, Suite 160, Austin, TX 78735. A copy of Terracon Report No. 96177607A, dated October 27, 2017, is bound hererin.

1.05 ASBESTOS SURVEY

A. An Asbestos Survey for the project site has been performed by Asbestos Consulting and Environmental (ACE), 4411 Spicewood Springs Road, Suite 402, Austin, Texas 78759. A copy of ACE Project No. A17-890, dated October 30, 2017, is bound hererin.

1.06 EXISTING CONDITIONS

A. Bidders shall visit the site of work, existing buildings, review any available existing drawings, and all conditions affecting the work of this project. Any claims after contract award for difficulties encountered which could have been foreseen by such site review will not be recognized by the Owner.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION
Not used.

END OF SECTION 00 30 00

Geotechnical Engineering Report

Georgetown Fire Station No. 7

E. University Avenue, West of NE Inner Loop

Georgetown, Texas

September 21, 2018

Terracon Project No. 96175283, Revision 1

Prepared for:

City of Georgetown

Georgetown, Texas

Prepared by:

Terracon Consultants, Inc.

Austin, Texas

Offices Nationwide
Employee-Owned
Established in 1965
terracon.com

Terracon

Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

September 21, 2018

Terracon

City of Georgetown
809 Martin Luther King Jr. Street
Georgetown, Texas 78626

Attn: Mr. Eric Johnson
P: 512.809.3145
E: eric.johnson@georgetown.org

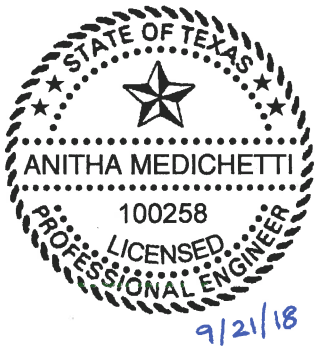
Re: Geotechnical Engineering Report
Georgetown Fire Station No. 7
E. University Avenue, West of NE Inner Loop
Georgetown, Texas
Terracon Project No. 96175283, Revision 1

Dear Mr. Johnson:

Terracon Consultants, Inc. (Terracon) is pleased to submit our revised Geotechnical Engineering Report for the Georgetown Fire Station No. 7 project in Georgetown, Texas. We trust that this report is responsive to your project needs. Please contact us if you have any questions or if we can be of further assistance.

We appreciate the opportunity to work with you on this project and look forward to providing additional Geotechnical Engineering and Construction Materials Testing services in the future.

Sincerely,
Terracon Consultants, Inc.
(TBPE Firm Registration: TX F3272)



M. Anitha
Anitha Medichetti, P.E.
Project Engineer

Bryan S. Moulin, P.E.
Principal, Geotechnical Department Manager

Copies Submitted: (1) Electronic

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EXECUTIVE SUMMARY

A geotechnical investigation has been performed for the proposed construction of the Georgetown Fire Station No. 7 project in Georgetown, Texas. Five (5) borings, designated B-1 through B-5, were performed to depths of approximately 5.5 to 20 feet below the existing grade in 2017. Since Terracon's Geotechnical Report No. 96175283 dated December 15, 2017, the building location has been changed. In addition, a future metal building has been added. Therefore, five (5) additional borings, designated B-6 through B-10 were performed to depths of approximately 20 feet. Based on the information obtained from our subsurface exploration, the site can be developed for this new proposed project. The following geotechnical considerations were identified:

- Stripping should include vegetation, loose soils, topsoils, debris, and other unsuitable materials, as well as the over-excavation required in the building areas.

- Once final subgrade elevations have been achieved, proofrolling should be performed to detect weak areas. Weak areas should be removed and replaced with select fill or soils exhibiting similar characteristics as the adjacent in-situ soils.

- For the loads anticipated for these structures, spread/strip footings placed to bear in select fill soils would be appropriate. Recommendations have been provided in **Section 4.3.1**.

- A monolithic slab-on-grade foundation system would be appropriate to support the proposed buildings. Recommendations have been provided in **Section 4.3.2**.

- Subgrade preparation recommendations have been provided in **Section 4.4**.

- Pavements in parking areas used by personal vehicles only should be designed with at least 2 inches of asphalt over 10 inches of base material over moisture conditioned subgrade. As an alternative, 5 inches of reinforced concrete over moisture conditioned subgrade may be used.

- Pavements in light to medium duty traffic areas used by personal vehicles only (if any) should be designed with at least 2.5 inches of asphalt over 12 inches of base material over moisture conditioned subgrade. As an alternative, 6 inches of reinforced concrete over moisture conditioned subgrade may be used.

- Pavements in fire truck areas (medium-heavy duty traffic areas) should be designed with at least 7 inches of reinforced concrete over moisture conditioned subgrade.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. **Section 5.0 – GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
GEORGETOWN FIRE STATION NO. 7
E. UNIVERSITY AVENUE, WEST OF NE INNER LOOP
GEORGETOWN, TEXAS

Terracon Project No. 96175283, Revision 1
September 21, 2018

1.0 INTRODUCTION

Terracon is pleased to submit our Geotechnical Engineering Report for the proposed construction of the Georgetown Fire Station No. 7 project in Georgetown, Texas. The project was authorized through signature of City of Georgetown's "Task Order No. TCI-18-015-TO" on July 25, 2018. Since Terracon's Geotechnical Report No. 96175283 dated December 15, 2017, the building location has been changed. In addition, a future metal building has been added. Therefore, additional borings were requested.

The purpose of this report is to describe the subsurface conditions observed at the original and recent borings drilled for this project, analyze and evaluate the test data, and provide recommendations with respect to:

- Foundation design and construction for the buildings;
- Site earthwork, subgrade preparation, and fill placement;
- Seismic site classification according to IBC 2015; and,
- Pavement design and construction;

2.0 PROJECT INFORMATION

2.1 Site Location and Description

Item	Description
Location	This project site is an approximately 3.08-acre tract located along E. University Avenue, west of NE Inner Loop in Georgetown, Texas (See Exhibit A-1 – Site Aerial and Location Plan).
Existing Improvements	Several warehouse buildings and paving.
Current Ground Cover	Existing structures, paving, grass, weeds, exposed soils and trees.

Item	Description
Existing Topography	Unknown at this time but based on visual observations and Google Earth®, the site within the proposed fire station building appears to be relatively flat. However, the site within the proposed future building appears to have a grade differential of about 5 to 6 feet.

2.2 Project Description

Item	Description
Site layout	See Exhibit A-2, Boring Location Plan, in Appendix A.
Proposed Improvements	The project is planned to include the construction of a single story fire station building and adjacent pavements for parking and access drives. A future metal building is also planned.
Building Construction	Typical light-frame construction anticipated.
Finished Floor Elevation, FFE	Unknown at this time, but assumed to be at or slightly above (≤2 feet) existing grades.
Maximum Loads (assumed)	Columns: Up to 150 kips Walls: 1 to 4 klf Slabs: 100 to 150 psf max.
Grading	Unknown at this time, but assumed ≤ 2 feet from existing grades.
Cut and Fill Slopes	None anticipated.
Free-Standing Retaining Walls	None anticipated.
Below-Grade Areas	None anticipated.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the borings, subsurface conditions on the project can be generalized as below.

Description	Approximate Depth Range of Stratum (feet)	Material Encountered	Consistency/Density
Stratum I	0 – 4.5	Dark Brown to Brown Fat Clay (CH) to Lean Clay (CL)	Stiff to Hard
Stratum II	2 – 20	Tan Lean Clay (CL) to Lean Clay with Sand (CL) to Sandy Lean Clay (CL) to Silty Clay (CL-ML) to Silty Clay with	Stiff to Hard; Dense to Very Dense

Description	Approximate Depth Range of Stratum (feet)	Material Encountered	Consistency/Density
		Sand (CL-ML) to Clayey Sand with Gravel (SC)	
Stratum III	8.5 – 20	Tan to Light Gray Fat Clay (CH)	Stiff to Hard

Conditions encountered at the boring locations are indicated on each individual boring log. Stratification boundaries on the boring logs represent the approximate location of changes in subsurface material types; in-situ, the transition between materials may be gradual. Details for the borings can be found on the boring logs on Exhibits A-4 through A-13 of Appendix A.

3.2 Groundwater

The borings were dry augered to completion depths of about 5.5 to 20 feet below existing grades. Groundwater was not encountered in any of the original and recent borings during drilling in 2017 and 2018.

Although not observed during our field exploration, groundwater at the site may be encountered in more pervious seams/fissures of the subgrade soils and/or in “perched” areas immediately above less permeable seams/layers of the subsurface soils. During periods of wet weather, zones of seepage may appear and isolated zones of “perched water” may become trapped (or confined) by zones possessing a low permeability. Groundwater conditions at the site could fluctuate as a result of seasonal and climatic variations. Please note that it often takes several hours/days for water to accumulate in a borehole, and geotechnical borings are relatively fast, short-term boreholes that are backfilled the same day. Long-term groundwater readings can more accurately be achieved using monitoring wells. Please contact us if this is desired. Groundwater conditions should be evaluated immediately prior to construction.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The following recommendations are based upon the data obtained in our field and laboratory programs, project information provided to us, and on our experience with similar subsurface and site conditions.

4.1 Geotechnical Considerations

Based on our test borings, highly to very highly (Stratum I) to moderately (Stratum II) expansive soils that exhibit a significant potential for volumetric change during moisture variations are

present near the ground surface. The subgrade soils at this site may experience expansion and contraction due to changes in moisture content. The soils exhibit a Potential Vertical Rise (PVR) of up to about 3 inches at the proposed building areas, as estimated by the Texas Department of Transportation (TxDOT) Method TEX-124-E, if present in a dry condition.

This report provides significant earthwork recommendations to help mitigate the effects of soil movements (shrinkage, expansion, settlement). However, even if these procedures are followed, some movements and at least some cracking in the structures should be anticipated. The severity of cracking and other cosmetic damage such as uneven floor slabs will probably increase if any modifications of the site result in excessive wetting of the expansive soils. Elimination of the risk of minor movement and cosmetic distress may not be possible, but the risk could be further reduced if significantly more expensive measures are used during construction. Please contact Terracon if this is desired.

4.2 Earthwork

Construction areas should be stripped of vegetation, topsoil, existing foundations, existing pavements, utilities, and other unsuitable material. Remnants of foundation units from existing structures to be demolished should be removed to a minimum depth of 24 inches below final subgrade elevation. All utilities and associated bedding material that are planned to be abandoned/demolished should be completely removed from within the proposed building area. If not possible, the abandoned utility lines should be thoroughly grouted and plugged with flowable fill.

Roots of trees to be removed within construction areas should be grubbed to full depths, including the dry soil around the roots. Once final subgrade elevations have been achieved (including the over-excavation required for building pad), the exposed subgrade should be carefully proofrolled with a 20-ton pneumatic roller or a fully loaded dump truck to detect weak zones in the subgrade. Weak areas detected during proofrolling, as well as zones containing debris or organics and voids resulting from removal of utilities, fill material, etc. should be removed and replaced with soils exhibiting similar classification, moisture content, and density as the adjacent in-situ soils. Proper site drainage should be maintained during construction so that ponding of surface runoff does not occur, which can cause construction delays and/or inhibit site access.

Subsequent to proofrolling, and just prior to placement of fill, the exposed subgrade within the construction areas should be evaluated for moisture and density. If the moisture and/or density requirements do not meet the criteria described in the table below, the soil subgrade should be scarified; moisture conditioned, and compacted as per **Section 4.2.1 – Minimum Compaction Requirements**. Select fill and on-site soils should meet the following criteria.

Fill Type [1]	USCS Classification	Acceptable Location For Placement
Imported Select Fill [2,3,4]	CL, SC, and/or GC (5≤PI≤20)	Select fill material should be used for all grade adjustments within the building limits.
General Fill [5]	CH, CL, CL-ML, SC	General fill is for use within other non-structural areas of the site. If imported, paving fill should exhibit a maximum PI of 40 or less.

1. Prior to any filling operations, samples of proposed borrow and/or on-site materials should be obtained for laboratory testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to evaluate that proper levels of compaction, including dry unit weight and moisture content, are being attained.
2. Imported select fill should consist of crushed limestone base material meeting the requirements of the Texas Department of Transportation (TxDOT) Standard Specifications Item 247, Type A, Grade 3, or a low-plasticity clayey soil with a plasticity index between 5 and 20 percent, a maximum gravel content (percentage retained on No. 4 sieve) of 40 percent, and rocks no larger than 4 inches in their largest dimension. Crushed concrete (per TxDOT Item 247, Type D, Grade 3 or better) is also acceptable provided it is free of reinforcing steel and other miscellaneous objects. As an alternative, a low-plasticity granular fill material which does not meet these specifications may be used only if approved by Terracon.
3. Based on the laboratory testing performed during this exploration, the on-site Stratum I soils are not suitable for re-use as select fill and the Stratum II tan soils are not consistently suitable for re-use as select fill. We do not recommend these soils be considered for re-use as select fill when planning budgets.
4. Excavated on-site soils, if free of organics, debris, and rocks larger than 4 inches, may be considered for use as fill in pavement, landscape, or other general areas. Please note that the on-site Stratum I soils can exhibit high shrink/swell potential. For economical reasons, expansive soils are often used in pavement and/or flatwork areas. The owner should be aware that the risk exists for future movements of the subgrade soils which may result in movement and/or cracking of pavements and/or flatwork. If paving fills are imported from another location, the maximum PI allowed for paving fill is 40.

4.2.1 Minimum Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

BENEATH SLAB AND ALL ASSOCIATED FLATWORK AREAS DEFINED AS WITHIN BUILDING AREA LIMITS

Material Type and Location	Per the Standard Proctor Test (ASTM D 698)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction	
		Minimum	Maximum
Crushed Limestone Base	95	-3%	+3%

Material Type and Location	Per the Standard Proctor Test (ASTM D 698)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction	
		Minimum	Maximum
Imported Select Fill	95	-3%	+3%
Moisture Conditioned Building Subgrade & General Fill	95	-3%	+3%

BENEATH PAVEMENTS AND OTHER NON-STRUCTURAL AREAS OF THE SITE

Material Type and Location		Per the Standard Proctor Test (ASTM D 698)		
		Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction	
			Minimum	Maximum
Paving Fill & Subgrade	PI ≤ 25	95	-3%	+3%
	PI > 25	95	Optimum	+4%
Crushed Limestone Base (beneath pavements, if used)		95 [1]	-3%	+3%

1. Per the Modified Proctor Test (ASTM D 1557).

Engineered fill materials should be placed in horizontal, loose lifts not exceeding 8 inches in thickness and should be thoroughly compacted. Where light compaction equipment is used, as is customary within a few feet of retaining walls and in utility trenches, the lift thickness may need to be reduced to achieve the desired degree of compaction.

We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

4.2.2 Grading and Drainage

The performance of the proposed structures will not only be dependent upon the quality of construction, but also upon the stability of the moisture content of the near-surface soils. Therefore, we highly recommend that site drainage be developed so that ponding of surface runoff near the structures does not occur. Accumulation of water near the buildings may cause significant moisture variations in soils adjacent to the structures, thus increasing the potential for structural distress.

Positive drainage away from the structures must be provided during construction and maintained through the life of the proposed project. Infiltration of water into excavations should be prevented during construction. It is important that foundation soils are not allowed to become

wetted. All grades must provide effective drainage away from the structures during and after construction. Exposed (unpaved) ground should be sloped at a minimum 5 percent away from the structures for at least 10 feet beyond the perimeter of the structures. Water permitted to pond next to the structures can result in greater soil movements than those discussed in this report. Estimated movements described in this report are based on effective drainage for the life of the structures and cannot be relied upon if effective drainage is not maintained.

Roof runoff and surface drainage should be collected and discharged away from the structures to prevent wetting of the foundation soils. Roof gutters should be installed and connected to downspouts and pipes directing roof runoff at least 10 feet away from the structures, or discharged on to positively sloped pavements.

Sprinkler mains and spray heads should preferably be located at least 5 feet away from the structures such that they cannot become a potential point source of water directly adjacent to the structures. In addition, the owner and/or builder should be made aware that placing large bushes and trees adjacent to the structures may cause significant moisture variations in the soils underlying the structures. In general, tree roots can adversely influence the subsurface soil moisture content to a distance of 1 to 1½ times the mature height of the tree and beyond the tree canopy. Watering of vegetation should be performed in a timely and controlled manner and prolonged watering should be avoided. Landscaped irrigation adjacent to the foundation units should be minimized or eliminated. Special care should be taken such that underground utilities do not develop leaks with time.

4.3 Foundation System

Based upon the subsurface conditions observed during this exploration and anticipated loading, we recommend the use of spread/strip footings placed to bear in select to support the proposed structures. As an alternative, a monolithic slab-on-grade foundation system placed to bear into the same materials would be appropriate to support the proposed structures. Recommendations for these types of foundation systems are presented below.

4.3.1 Design Recommendations – Spread/Strip Footings

For the proposed structures, principal column and wall loads may be supported on isolated (spread) and/or continuous (strip) footings embedded at least 2 feet below the ground surface on select fill.

Description		Shallow Footing Design Parameter
Bearing Stratum		Compacted Select Fill
Minimum Embedment Below Final Grade [1]		2 feet below final grade
Bearing Pressures (net	**Select Fill**	2,500 psf

Description		Shallow Footing Design Parameter
allowable total load)		
Minimum Footing Dimensions	**Continuous (Strip)**	24 inches wide
	Isolated (Spread)	3 feet by 3 feet square
Approximate Total Movement [2]		1-inch
Estimated Differential Movement [3]		½ to ¾-inch
Allowable Passive Resistance [4]		300 psf per foot of depth
Coefficient of Sliding Friction [5]		0.35
Uplift Resistance [6]		Foundation Weight (150 pcf) & Soil Weight (120 pcf)

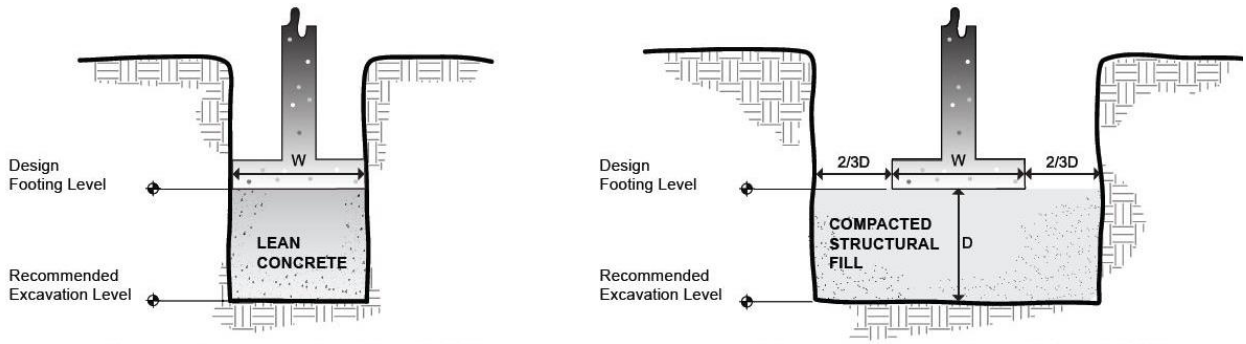
1. The minimum embedment is intended to provide footings that bear on select fill.
2. This estimated post-construction settlement of the shallow footings is assuming proper construction practices are followed.
3. Differential settlements may result from variances in subsurface conditions, loading conditions and construction procedures. The settlement response of the footings will be more dependent upon the quality of construction than upon the response of the subgrade to the foundation loads.
4. Passive resistance should be neglected in the first 12 inches below existing grade. Care should be taken to avoid disturbance of the footing bearing area since loose material could increase settlement and decrease resistance to lateral loading. If the footing is formed during construction, the open space between the footing and the in-situ soils should be backfilled with concrete.
5. Lateral loads transmitted to the footings will be resisted by a combination of soil-concrete friction on the base of the footings and passive pressure on the side of the footings. We recommend that the allowable frictional resistance be limited to 500 psf for select fill.
6. The ultimate uplift capacity of shallow footings should be reduced by an appropriate factor of safety to compute allowable uplift capacity.

4.3.2 Foundation Construction Considerations for Spread/Strip Footings

Grade beams/footings should be neat excavated if possible. If neat excavation is not possible, the foundation should be properly formed. If a toothed bucket is used, excavation with this bucket should be stopped approximately 6 inches above final grade and the grade beam excavation completed with a smooth-mouthed bucket or by hand labor. Debris in the bottom of the excavation should be removed prior to steel placement. The foundation excavation should be sloped sufficiently to create internal sumps for runoff collection and removal. If surface runoff water or groundwater seepage in excess of one inch accumulates at the bottom of the foundation excavation, it should be collected, removed, and not allowed to adversely affect the quality of the bearing surface.

If additional unsuitable soils such as low strength or disturbed soils are encountered below the design footing elevation, the footing excavations should be deepened to expose suitable bearing materials and backfilled with either lean concrete or granular material. If lean concrete

backfill (minimum 28-day compressive strength of 1,500 psi) is used, widening of the footing excavation will not be required. For granular (crushed limestone or clean well-graded granular material) backfill beneath footings, the excavations should be widened at least 8 inches beyond each footing edge for every foot of new fill placed below the design footing base elevation. The overexcavated depth should then be backfilled up to the foundation base elevation with approved material, placed in lifts and compacted to at least 95% of the material's standard Proctor (ASTM D 698) maximum dry density. The recommended extents of the overexcavation and backfill procedure are illustrated in the following figure.



NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

Concrete should be placed as soon as possible after excavation to reduce bearing soil disturbance. Soils at bearing level that become disturbed or saturated should be removed prior to placing reinforcing steel and concrete. Adequate water control/dewatering system will aid in minimizing need for over-excavation and backfill of any soils disturbed by prolonged exposure. It is important that the foundation subgrade not be disturbed by construction activities (e.g., setting forms and placing reinforcing steel). If disturbance occurs, we recommend that the disturbed soils be removed and that the foundation subgrade be protected with the placement of a lean concrete "mud mat".

4.3.3 Design Recommendations – Monolithic Slab-on-Grade

Monolithic slab-on-grade foundation systems (either conventionally reinforced or post-tensioned) would also be appropriate to support the proposed buildings provided subgrade preparation as described in ***Section 4.4 – Building Pad Preparation*** is followed to reduce the shrink/swell potential of the near-surface subgrade soils. The slab foundation design parameters presented in the tables below are based on the criteria published by the Building Research Advisory Board (BRAB), the Prestressed Concrete Institute (PCI), the Wire Reinforcement Institute (WRI), and the Post-Tensioning Institute (PTI) 3rd Edition. These are essentially empirical design methods and the recommended design parameters are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study, our area experience, and the criteria published in the BRAB, PCI, WRI, and PTI design manuals.

Conventional Slab and Beam System Parameters	
Minimum embedment of grade beams below final grade[1]	18 inches
Bearing Pressures (allowable) [2]	Net dead plus sustained live load – 1,700 psf Net total load – 2,500 psf
Subgrade Modulus (k) [3]	150 pci
Approximate Potential Vertical Rise (PVR)	3 inches (About 1-inch) [4,5]

1. Embedment is to reduce surface water migration below the foundation elements and to develop proper end bearing and is not based on structural considerations. The grade beam width and depth should be properly evaluated by the structural engineer. Grade beams may be thickened and widened at interior column locations to serve as spread footings at these concentrated load areas.
2. Grade beams should bear on compacted select fill soils.
3. Several design methods use the modulus of subgrade reaction, k, to account for soil properties in design of flat, floor slabs. The modulus of subgrade reaction is a spring constant that depends on the kind of soil, the degree of compaction, and the moisture content. Based on our recommendations provided in **Section 4.4**, the above indicated subgrade modulus can be used for design of a flat, grade-supported floor slab.
4. Differential movements may result from variances in subsurface conditions, loading conditions and construction procedures. We recommend that measures be taken whenever practical to increase the tolerance of the building to post-construction foundation movements. An example of such measures would be to provide frequent control joints for exterior masonry veneers and interior sheetrock walls (particularly near doors and windows) to control cracking across such walls and concentrate movement along the joints.
5. The building subgrade should be properly prepared as described in **Section 4.4** below.

BRAB/WRI/PCI Parameters			
Design Plasticity Index (PI) [1]	**BRAB**	**Unprepared Subgrade**	51
		Prepared Subgrade (as in Section 4.4)	18
	WRI/PCI	**Unprepared Subgrade**	28
		Prepared Subgrade (as in Section 4.4)	18
Climatic Rating (C_w)			17
Unconfined Compressive Strength			1.0 tsf
Soil Support Index (C) for BRAB	**Unprepared Subgrade**		0.63
	Prepared Subgrade (as in Section 4.4)		0.97

1. The BRAB effective PI is equal to the near surface PI if that PI is greater than all of the PI values in the upper 15 feet. If the near-surface PI is not highest (i.e., after the building pad is prepared), then the effective PI is the weighted average of the upper 15 feet. The WRI/PCI effective PI is always the weighted average of the PI values in the upper 15 feet.

Post Tensioning Institute (PTI) Parameters[1]		
Maximum Depth of Seasonal Moisture Change[2]		15 feet
Plasticity Index [3]		Select Fill – 15 Stratum I Soils – 29 to 51 (average ~ 40) Stratum II Soils – 6 to 24 (average ~ 15) Stratum III Soils - 39 to 58 (45)
Percent Finer than 2 Microns (estimated) [3]		Select Fill – 20 (estimated) Stratum I Soils – 55 (estimated) Stratum II Soils – 38 (measured) Stratum III Soils – 60 (estimated)
Soil Fabric Factor		1.0
Approximate Thornthwaite Moisture Index		-12
Estimated Constant Soil Suction		3.5 pF
Range of Soil Suction		3.0 to 4.5 pF
Edge Moisture Variation Distance, e_m [4, 5]	**Center Lift**	7.2 feet (8.3 feet) [6]
	Edge Lift	3.8 feet (4.3 feet) [6]
Differential Soil Movement, y_m [5]	**Center Lift**	1.8 inches (0.8 inches) [6]
	Edge Lift	3 inches (1.1 inches) [6]

1. Based on our analysis of the field and laboratory data, design parameters were computed using the Addendum to the 2004 Post-Tensioning Institute (PTI) method[1] for slab-on-grade design and the subsequent Errata to the Addendum approved by the PTI Slab-on-Grade Committee on February 7, 2008.
2. The moisture beneath a shallow foundation will change in response to wetting and drying conditions around the foundation perimeter. The moisture condition has a significant effect on slab behavior and is highly variable with time, changing seasonally, with annual climate conditions, drainage patterns, ground cover, and vegetation (trees and shrubs).
3. The plasticity index and the clay mineral percentage are values of the soil that can be estimated by laboratory tests, and, although variable from location to location, remain relatively constant with time.
4. The maximum moisture variation distance is termed the edge moisture variation distance, e_m, and is an important factor governing the design of post-tensioned floor slabs. The e_m is related to percent fine clay and climatic conditions as well as other parameters, such as soil fabric factor and unsaturated diffusion coefficient.
5. The differential movements, y_m, and edge moisture variation distances, e_m, were calculated by modeling soil profiles using the commercial software program VOLFLO as recommended by the PTI manual.
6. Values may be used provided subgrade preparation is implemented as described in **Section 4.4** below.

1. Post-Tensioning Institute, "Addendum No. 1 to the 3rd Edition of the Design of Post-Tensioned Slabs-on-Ground", Post-Tensioning Institute, Phoenix, AZ, May 2007.

When considering a grade-supported floor slab, the design of the floor slab involves the interaction of the floor slab and the soil support system to resist moments and shears induced by the applied structural loads. Floor slabs can be thickened, or stiffening beams can be added, to aid in resisting moments and shears. The Stratum I fat clay soils can be a concern at this site. We recommend that the potential effects of these soils be reduced by following the recommendations presented in **Section 4.4 – Building Pad Preparation**. Joints should be constructed at regular intervals as recommended by the American Concrete Institute (ACI) to help control the location of any cracking.

For a slab foundation system designed and constructed as recommended in this report, post construction settlements should be about 1-inch. Settlement response of a select fill supported slab is influenced more by the quality of construction than by soil-structure interaction. Therefore, it is essential that the recommendations for foundation construction be strictly followed during the construction phases of the building pad and foundation.

The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture-sensitive or impervious coverings, or when the slabs will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions about the use and placement of a vapor retarder.

4.3.4 Foundation Construction Considerations for Monolithic Slab-On-Grade

Grade beams should be neat excavated if possible. If neat excavation is not possible, the foundation should be properly formed. If a toothed bucket is used, excavation with this bucket should be stopped approximately 6 inches above final grade and the grade beam excavation completed with a smooth-mouthed bucket or by hand labor. Debris in the bottom of the excavation should be removed prior to steel placement. The foundation excavation should be sloped sufficiently to create internal sumps for runoff collection and removal. If surface runoff water or groundwater seepage in excess of one inch accumulates at the bottom of the foundation excavation, it should be collected, removed, and not allowed to adversely affect the quality of the bearing surface.

Concrete should be placed as soon as possible after excavation to reduce bearing soil disturbance. Soils at bearing level that become disturbed or saturated should be removed prior to placing reinforcing steel and concrete. Adequate water control/dewatering system will aid in minimizing need for over-excavation and backfill of any soils disturbed by prolonged exposure. It is important that the foundation subgrade not be disturbed by construction activities (e.g., setting forms and placing reinforcing steel). If disturbance occurs, we recommend that the disturbed soils be removed and that the foundation subgrade be protected with the placement of a lean concrete “mud mat”.

If utilized, the post-tensioned slab-on-grade construction technique should be carefully monitored by qualified personnel. The sophistication of this construction procedure requires careful attention to details such as concrete integrity and anchorages, along with tendon spacing, support, covering, and stressing. Poor construction could result in a non-functional slab foundation system.

4.3.4.1 Foundation Construction Monitoring

The performance of the selected foundation system for the proposed structures will be highly dependent upon the quality of construction. Thus, we recommend that the foundation installation be monitored by Terracon to identify the proper bearing strata and depths and to help evaluate foundation construction. We would be pleased to develop a plan for foundation monitoring to be incorporated in the overall quality control program.

4.4 Building Pad Preparation

Information about proposed grades and FFE for the proposed buildings has not been provided to Terracon at this time. However, Terracon is assuming that the structure will be at or slightly above (≤ 2 feet) from existing grades. If this is incorrect, Terracon should be notified to review and modify and/or verify recommendations in writing. **Please provide grading and FFE information to Terracon as soon as it is known for verification of the below recommendations.**

In order to limit post-construction movements to approximately 1-inch, the on-site Stratum I dark brown to brown clay soils (observed to be 2 to 4.5 feet thick) should be completely excavated and removed from all building areas. If the Stratum II tan soils are exposed, the excavation may be shallowed, but in no case should the select fill thickness be less than 3 feet below the slab. **All fill material placed within the building footprint should meet the requirements of Select Fill described in Section 4.2 – Earthwork**.

Prior to placement and compaction of select fill, the subgrade should be thoroughly proofrolled with a 20-ton roller to detect weak zones in the existing fill subgrade as discussed in **Section 4.2 – Earthwork**. Material and placement requirements for select fill, as well as other subgrade preparation recommendations, are presented in **Section 4.2 – Earthwork**. We suggest the use of crushed limestone base as the select fill material from a standpoint of construction access during wet weather, as well as from a standpoint of floor slab support.

For any flatwork (sidewalks, ramps, etc.) outside of the building areas which will be sensitive to movement, subgrade preparation as discussed above for the interior floor slab should be strongly considered to reduce differential movements between the flatwork and the adjacent building. If subgrade preparation as given above for building areas is not implemented in the exterior flatwork areas, those areas may be susceptible to post-construction movements in excess of that given above. If the movement occurs, it could result in reversed drainage and possible flow of surface runoff towards the structure. Maximum grades practical should be used

for flatwork to prevent water from ponding adjacent to the structure. Allowances in final grades should also consider the potential post-construction movement of the flatwork. Where flatwork abuts the structure, effectively seal and maintain the joints to prevent surface water infiltration.

We should also note that the potential movement values indicated are based upon moisture variations in the subgrade due to circumstances such as moisture increases due to rainfall and loss of evapotranspiration. In circumstances where significant water infiltration beneath the floor slab occurs (such as those discussed in **Section 4.2.2 – Grading and Drainage**), movements in isolated floor slab areas could potentially be in excess of those indicated in this report.

The post-construction performance of the foundation will likely be influenced more by post-construction volumetric changes of the subgrade due to in-situ moisture variations than upon settlement due to foundation loads. Settlement response of surface slabs will be influenced as much by the quality of construction and fill placement as by soil-structure interaction.

4.5 Seismic Design Information

Code Used	Seismic Design Category	Site Class Designation
2015 International Building Code (IBC)	A[1]	D[2]

1 Per IBC 2015 Section 1613.3.1.

Per IBC 2015, S_s=0.063; S_1=0.035; S_{MS}=0.101; S_{M1}=0.085; S_{DS}=0.068; S_{D1}=0.056

2 Per IBC 2015 Section 1613.3.2. The IBC requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope does not include the required 100 foot soil profile determination. Borings extended to a maximum depth of approximately 20 feet and this seismic site class definition assumes materials with similar characteristics are below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a higher seismic class.

4.6 Pavements

Both flexible (asphaltic concrete) and rigid (reinforced Portland cement concrete) pavement systems may be considered for site pavement applications. These two types of pavement are not considered equal. Over the life of the pavement, concrete pavements would be expected to exhibit better performance and require less maintenance. At a minimum, concrete pavements should be strongly considered in all fire truck areas, as well as waste collection areas and delivery truck loading/unloading areas.

Detailed traffic loads and frequencies were not available for the pavements. However, we anticipate that most pavement will be used by fire trucks (DI-3); however, there will be some limited parking spaces used primarily by passenger vehicles (assumed as the DI-1 light duty pavements) and there might be some driveway areas only served by passenger vehicles combined with occasional delivery trucks (assumed as DI-2 light-medium duty pavements).

Tabulated below are the assumed traffic frequencies and loads used to design pavement sections for this project.

PAVEMENT TYPE	TRAFFIC DESIGN INDEX	DESCRIPTION
Parking Areas (Passenger (Vehicles Only)	DI-1	Light traffic – Few vehicles heavier than passenger cars, panel, and pick-up trucks; no regular use by heavily loaded two-axle trucks or lightly loaded larger vehicles. (ESAL's[1] < 5)
Driveways and dumpster enclosures: (Light-Medium Duty)	DI-2	Light to Medium traffic – Similar to DI-1, including not over 50 heavily loaded two-axle trucks or lightly loaded larger vehicles per day. No regular use by heavily loaded trucks with three or more axles. (ESAL's[1] = 6 – 20)
Firetruck Driveways (Medium-Heavy Duty)	DI-3	Medium to heavy traffic – Including not over 300 heavily loaded two-axle trucks or lightly loaded trucks with three or more axles and no more than 30 heavily loaded trucks with more than three axles per day. (ESAL's[1] = 21 – 75)

1. Equivalent daily 18-kip single axle load applications.

Listed below are pavement component thicknesses which may be used as a guide for pavement systems at the site assuming that the on-site soils will generally act as the pavement subgrade, and that the pavement subgrade is prepared as outlined in the "Moisture Conditioned Subgrade" portion of this section and in accordance with our general recommendations for site preparation in **Section 4.2 – Earthwork**. We should note that these systems were derived based on general characterization of the subgrade. No specific testing (such as CBR, resilient modulus tests, etc.) was performed for this project to evaluate the support characteristics of the subgrade.

FLEXIBLE PAVEMENT SYSTEM

Component	Material Thickness (Inches)	
	DI-1	DI-2
Asphaltic Concrete (HMAC)	2.0	2.5
Crushed Limestone Base	10.0	12.0
Moisture Conditioned Subgrade	6.0	6.0
Total Thickness	16.0	18.5

RIGID PAVEMENT SYSTEM

Component	Material Thickness (Inches)		
	DI-1	DI-2	DI-3
Reinforced Concrete (PCC)	5.0	6.0	7.0
Moisture Conditioned Subgrade	6.0	6.0	6.0

Reinforcing Steel: #3 bars spaced at 18 inches on centers in both directions.

Control Joint Spacing: In accordance with ACI 330R-08, control joints should be spaced no greater than 12.5 feet for 5-inch thick concrete and no greater than 15 feet for 6-inch thick or greater concrete. If sawcut, control joints should be cut within 6 to 12 hours of concrete placement. Sawcut joints should be at least ¼ of the slab thickness.

Expansion Joint Spacing: ACI-330R-8 indicates that regularly spaced expansion joints are not needed when control joints are properly spaced. Their use should be limited to isolating fixed objects (such as light poles, landscape islands, and building) within or abutting the pavement. Therefore, the installation of expansion joints for routine use is optional and should be evaluated by the design/construction team. Expansion joints, if not sealed and maintained, can allow infiltration of surface water into the subgrade. At a minimum, an expansion joint (used as a construction joint) should be placed at the termination of each day's concrete placement. These joints should be fully sealed.

Dowels at Expansion Joints: ¾-inch smooth bars, 18 inches in length, with one end treated to slip, spaced at 12 inches on centers at each joint.

Presented below are our recommended material requirements for the various pavement sections.

Hot Mix Asphaltic Concrete (HMAC) – The asphaltic concrete surface course should be plant mixed, hot laid Type D (Fine-Graded Surface Course) meeting the master specification requirements in TxDOT Item 340. For acceptance and payment evaluation purposes, we recommend the use of the provisions in TxDOT Item 341.

Reinforced Portland Cement Concrete (PCC) – Concrete should be designed to exhibit a minimum 28-day compressive strength of 3,500 psi.

Crushed Limestone Base – Base material should be composed of crushed limestone meeting the requirements of TxDOT Item 247, Type A, Grade 1-2. The base should be compacted to a minimum of 95 percent of the maximum density as determined by the modified moisture/density relation (ASTM D 1557) at -3 to +3 percent of optimum moisture content. (As an option, compaction to at least 100 percent of the TEX-113-E maximum dry density may also be considered.) Each lift of base should be thoroughly proofrolled just prior to placement of subsequent lifts and/or asphalt. Particular attention should be paid to areas along curbs, above utility trenches, and adjacent to landscape islands, manholes, and storm drain inlets. Placement of the base material should extend at least 18 inches behind curbs.

Moisture Conditioned Subgrade – The soil subgrade should be scarified to a depth of 6 inches, moisture conditioned and recompacted as per **Section 4.2.1 – Minimum Compaction Requirements**. Care should be taken such that the subgrade does not dry out or become saturated prior to pavement construction. The pavement subgrade should be thoroughly proofrolled with a rubber-tired vehicle (fully loaded water or dump truck) immediately prior placement of base material. Particular attention should be paid to areas along curbs, above utility trenches, and adjacent to landscape islands, manholes, and storm drain inlets. Placement of the moisture conditioned subgrade should extend at least 24 inches behind curbs.

Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as the Stratum I clay soils. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. It is, therefore, important to minimize moisture changes in the subgrade to reduce shrink/swell movements. Proper perimeter drainage should be provided so that infiltration of surface water from unpaved areas surrounding the pavement is minimized.

On most projects, rough site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas; dry weather may desiccate some areas; rainfall and surface water saturates some areas; heavy traffic from concrete and other delivery vehicles disturbs the subgrade; and many surface irregularities are filled in with loose soils to temporarily improve subgrade conditions. As a result, the pavement subgrade should be carefully evaluated as the time for pavement construction approaches. This is particularly important in and around utility trench cuts. All pavement areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to paving. Thorough proofrolling of pavement areas using a fully-loaded water truck or dump truck (rubber-wheeled vehicle that can impart point wheel loads) should be performed no more than 36 hours prior to surface paving. Any problematic areas should be reworked and compacted at that time.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventive maintenance. The following recommendations should be considered at a minimum:

- Adjacent site grading at a minimum 2% grade away from the pavements;
- A minimum ¼ inch per foot slope on the pavement surface to promote proper surface drainage;
- Install joint sealant and seal cracks immediately;
- Placing compacted, low permeability clay backfill against the exterior side of curb and

gutter; and,
- Placing curb and gutters through any base material and directly on subgrade soils.

Preventive maintenance should be planned and provided for through an on-going pavement management program. These activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance. This is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide testing and observation during excavation, grading, foundation installation, and other construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include, either specifically or by implication, any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

For any excavation construction activities at this site, all Occupational Safety and Health Administration (OSHA) guidelines and directives should be followed by the Contractor during construction to provide a safe working environment. In regards to worker safety, OSHA Safety and Health Standards require the protection of workers from excavation instability in trench situations.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical

engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

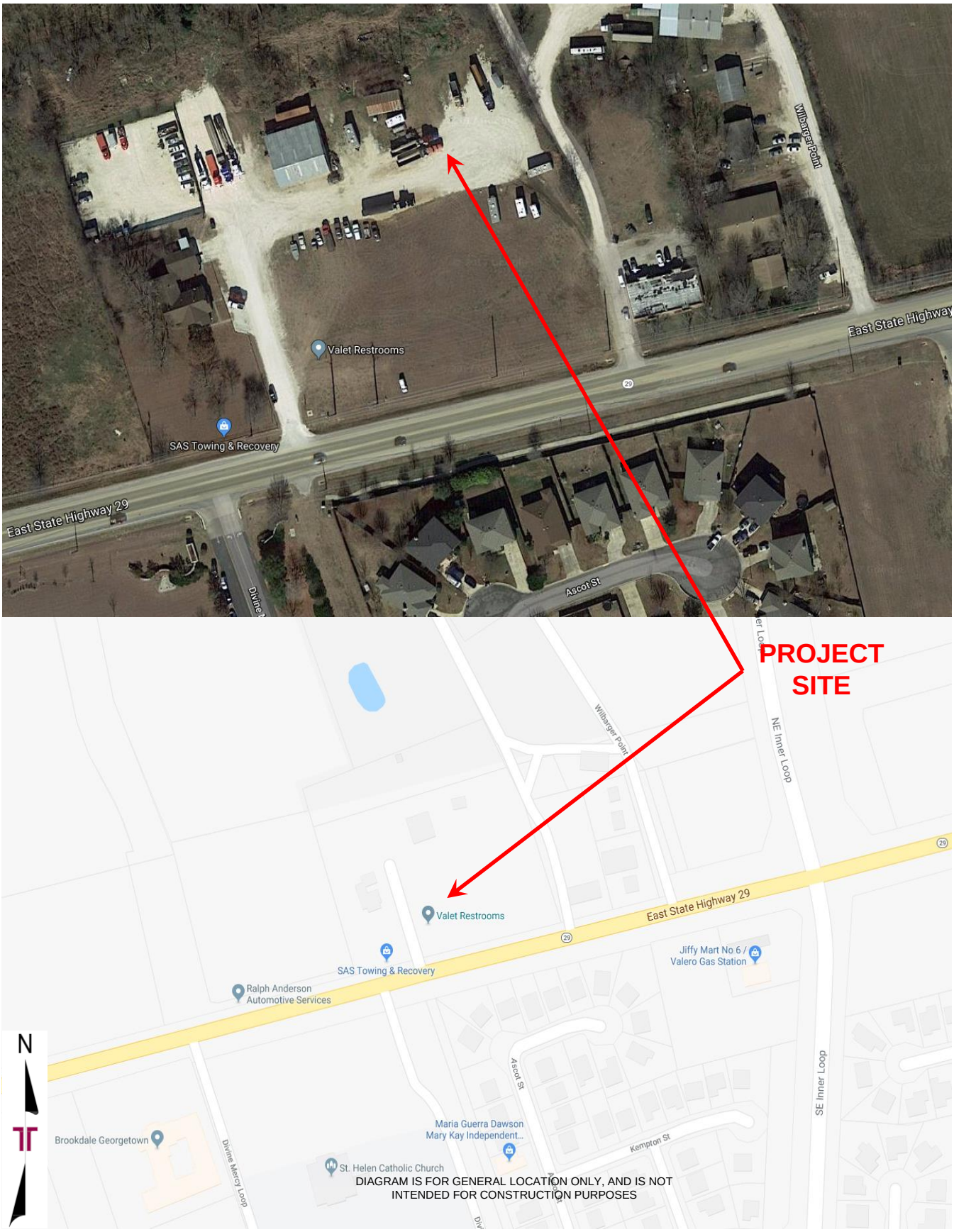
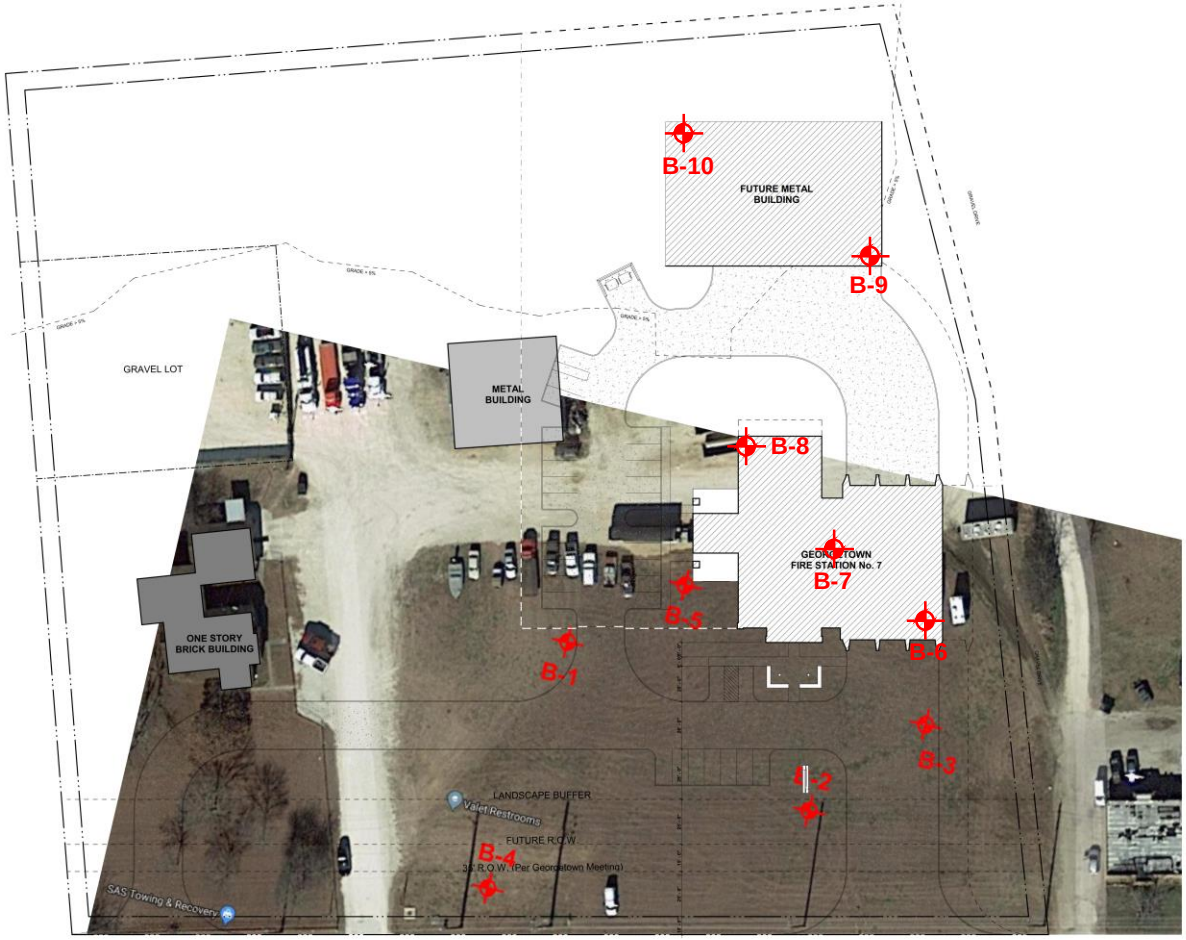


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Mgr: AM	Project No. 96175283	Terracon Consulting Engineers & Scientists	SITE AERIAL AND LOCATION PLAN
Drawn By: AM	Scale: N.T.S	5307 Industrial Oaks Blvd, Suite 160, Austin, Texas 78735	Georgetown Fire Station No. 7 E. University Avenue, W of NE Inner Loop Georgetown, Texas
Checked By: BSM	File Name: SITE PLAN	PH. {512} 442-1122 FAX. {512} 442-1181	EXHIBIT A-1
Approved By: BSM	Date: 9/20/2018		



N

Boring Locations

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Mgr: AM	Project No. 96175283	Terracon Consulting Engineers & Scientists	BORING LOCATION PLAN
Drawn By: AM	Scale: N.T.S	5307 Industrial Oaks Blvd, Suite 160, Austin, Texas 78735	Georgetown Fire Station No. 7 E. University Avenue, W of NE Inner Loop Georgetown, Texas
Checked By: BSM	File Name: SITE PLAN	PH. {512} 442-1122 FAX. {512} 442-1181	EXHIBIT A-2
Approved By: BSM	Date: 9/19/2018		

Field Exploration Description

Subsurface conditions were evaluated by drilling five borings (B-1 through B-5) to depths of about 5 to 20 feet below existing grades in 2017. In 2018, five additional borings (B-6 through B-10) were drilled to depths of about 20 feet below existing grades. The borings were drilled with truck-mounted rotary drilling equipment at the approximate locations shown on Exhibit A-2 of Appendix A. Boring depths were measured from the existing ground surface at the time of our field activities. The boring coordinates were located in the field through the use of a Garmin handheld GPS unit. The coordinates are presented on the top of the boring logs. Ground surface elevations were approximated from Google Earth®. These estimated surface elevations should be updated once the Client or Civil Engineer has a professional topographic site survey. Please provide such information to Terracon for boring log revisions.

The boring logs, which include the subsurface descriptions, types of sampling used, and additional field data for this study, are presented in Appendix A. Criteria defining terms, abbreviations and descriptions used on the boring logs are presented in Appendix C.

When possible, surficial soil samples were recovered using thin-walled, open-tube samplers (Shelby tubes). A pocket penetrometer test was performed on each sample of cohesive soil in the field to serve as a general measure of consistency.

Soils were sampled by means of the Standard Penetration Test (SPT). This test consists of measuring the number of blows required for a 140-pound hammer free falling 30 inches to drive a standard split-spoon sampler 12 inches into the subsurface material after being seated 6 inches. This blow count or SPT “N” value is used to estimate the engineering properties of the stratum. A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

Samples were removed from the samplers in the field, visually classified, and appropriately sealed in sample containers to preserve the in-situ moisture contents. Samples were then placed in core boxes for transportation to our laboratory in Austin, Texas.

BORING LOG NO. B-1

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6387° Longitude: -97.646°

Approximate Surface Elev: 763 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
		FAT CLAY (CH) Stiff, dark brown to brown, with trace gravel and sand			3-5-9 N=14				17		58-21-37	
2.0	761+/-											
		LEAN CLAY (CL) Stiff to hard, tan, with calcareous nodules			10-5-5 N=10							
			5		6-10-25 N=35							
					7-7-11 N=18							
8.5	754.5+/-											
		FAT CLAY (CH) Stiff to hard, tan to light gray, shaley			2-5-7 N=12				23		80-22-58	
			10									
					4.5 tsf (HP)		2.08	8.8	18	107	57-18-39	
			15									
20.0	743+/-				4-10-12 N=22							
		Boring Terminated at 20 Feet	20									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 11-21-2017 | Boring Completed: 11-21-2017

Drill Rig: CME 55 | Driller: Austin Geologic

Project No.: 96175283 | Exhibit: A-4

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-2

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6385° Longitude: -97.6455°

Approximate Surface Elev: 763 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
		FAT CLAY (CH) Very stiff, dark brown to brown, with trace gravel				4.0 tsf (HP)							
3.0	760+/-					4.5 tsf (HP)		7.02	7.9	20	106	40-17-23	90
		LEAN CLAY (CL) Stiff to hard, tan, with calcareous nodules	5			6-4-7 N=11							
						7-15-20 N=35				15		27-15-12	
		-with cemented seams below 8.5 feet	10			24-37-40 N=77							
13.5	749.5+/-												
		CLAYEY SAND WITH GRAVEL (SC) Very dense, tan, with calcareous nodules				12-50/2"				5		28-18-10	38
18.5	744.5+/-		15										
		FAT CLAY (CH) Very stiff, tan to light gray, shaley				6-12-17 N=29							
20.0	743+/-		20										
		Boring Terminated at 20 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 11-21-2017 | Boring Completed: 11-21-2017

Drill Rig: CME 55 | Driller: Austin Geologic

Project No.: 96175283 | Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-3

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6387° Longitude: -97.6454°

Approximate Surface Elev: 763 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
		FAT CLAY (CH) **Hard, dark brown to brown**				4.5 tsf (HP)							
						4.5 tsf (HP)							
	4.0	759+/-											
		LEAN CLAY (CL) **Very stiff, tan, with calcareous nodules**	5			6-7-11 N=18				13		31-15-16	
	5.5	757.5+/-											
		Boring Terminated at 5.5 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 5.5 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 11-21-2017 | Boring Completed: 11-21-2017

Drill Rig: CME 55 | Driller: Austin Geologic

Project No.: 96175283 | Exhibit: A-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-4

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6383° Longitude: -97.6461°

Approximate Surface Elev: 762 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
		FAT CLAY (CH) **Very stiff to hard, dark brown to brown**				4.5 tsf (HP)		5.78	8.7	22	98	71-20-51	
						4.0 tsf (HP)							
	4.0	758+/-											
		LEAN CLAY (CL) **Stiff, tan, with calcareous nodules**	5			9-5-6 N=11							
	5.5	756.5+/-											
		Boring Terminated at 5.5 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 5.5 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 11-21-2017 | Boring Completed: 11-21-2017

Drill Rig: CME 55 | Driller: Austin Geologic

Project No.: 96175283 | Exhibit: A-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-5

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6388° Longitude: -97.6458°

Approximate Surface Elev: 763 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
		FAT CLAY (CH) **Hard, dark brown to brown**				4.5 tsf (HP)							
	3.0	760+/-				4.5 tsf (HP)		5.88	9.5	14	108	42-18-24	
		LEAN CLAY (CL) **Very stiff to hard, tan, with calcareous nodules**				7-9-9 N=18							
	5.5	757.5+/-	5										
		Boring Terminated at 5.5 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 5.5 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 11-21-2017 | Boring Completed: 11-21-2017

Drill Rig: CME 55 | Driller: Austin Geologic

Project No.: 96175283 | Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-6

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6388° Longitude: -97.6454°

Approximate Surface Elev: 763 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
				4.5 tsf (HP)	UC	11.95	4.6	13	110	62-22-40	
				4.5 tsf (HP)							
4.0	759+/-										
SILTY CLAY WITH SAND (CL-ML) **Hard, tan**		5		12-23-24 N=47				10		21-15-6	80
				20-45-49 N=94							
-with cemented seams below 9.5 feet		10		31-47-50/5"							
				50/2"							
18.0	745+/-	15									
SANDY LEAN CLAY (CL) **Hard, tan, with cemented seams**				21-23-27 N=50				14			57
20.0	743+/-	20									
Boring Terminated at 20 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 08-21-2018 | Boring Completed: 08-21-2018

Drill Rig: Mobile B-59 | Driller: Core Tech Drilling, Inc.

Project No.: 96175283 | Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-7

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6389° Longitude: -97.6456°

Approximate Surface Elev: 763 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
				4.5 tsf (HP)							
				4.5 tsf (HP)	UC	4.92	5.1	14	108	48-19-29	
4.0	759+/-										
SILTY CLAY (CL-ML) **Hard, tan, with cemented seams**		5		11-17-23 N=40							
				23-31-50 N=81				12		21-15-6	90
-with increasing cemented seams below 9.5 feet				36-50/5"							
		10									
				50/1"							
16.0	747+/-	15									
FAT CLAY (CH) **Hard, tan to light gray, shaley**											
				4.5 tsf (HP)				16		62-19-43	
20.0	743+/-	20									
Boring Terminated at 20 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 08-21-2018 | Boring Completed: 08-21-2018

Drill Rig: Mobile B-59 | Driller: Core Tech Drilling, Inc.

Project No.: 96175283 | Exhibit: A-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-8

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.639° Longitude: -97.6457°

Approximate Surface Elev: 763 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
		FAT CLAY (CH) **Stiff, dark brown to brown**			7-4-7 N=11							
2.5	760.5+/-	**LEAN CLAY WITH SAND (CL)** **Very stiff to hard, tan, with gravel**	5		6-8-11 N=19				13		32-16-16	75
					5-13-17 N=30							
		-with cemented seams below 7 feet			24-50/6"							
			10		50/3"							
					50/5"				6		30-15-15	
16.0	747+/-		15									
		FAT CLAY (CH) **Hard, tan to light gray, shaley**			4.5 tsf (HP)							
20.0	743+/-		20									
		Boring Terminated at 20 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 08-21-2018 | Boring Completed: 08-21-2018

Drill Rig: Mobile B-59 | Driller: Core Tech Drilling, Inc.

Project No.: 96175283 | Exhibit: A-11

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-9

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6393° Longitude: -97.6456°

Approximate Surface Elev: 761 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
	LEAN CLAY (CL) **Hard, brown, with gravel**			4.5 tsf (HP)				8	122	37-17-20	
4.0	757+/-			10-12-16 N=28							
	LEAN CLAY (CL) **Very stiff to hard, tan**	5		8-8-11 N=19							
				15-12-22 N=34							
8.5	752.5+/-										
	FAT CLAY (CH) **Very stiff to hard, tan to light gray, shaley**			8-9-18 N=27				21		57-17-40	99
		10									
				4.5 tsf (HP)				13			
		15									
20.0	741+/-			4.5 tsf (HP)							
	Boring Terminated at 20 Feet	20									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 08-21-2018 | Boring Completed: 08-21-2018

Drill Rig: Mobile B-59 | Driller: Core Tech Drilling, Inc.

Project No.: 96175283 | Exhibit: A-12

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

BORING LOG NO. B-10

PROJECT: Georgetown Fire Station No. 7

CLIENT: City of Georgetown TX
Georgetown, TX

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

LOCATION See Exhibit A-2

Latitude: 30.6394° Longitude: -97.646°

Approximate Surface Elev: 755 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
	FAT CLAY (CH) **Hard, dark brown to brown, with gravel**					4.5 tsf (HP)							
						10-16-16 N=32							
4.5	750.5+/-		5			25-43-24 N=67				2		27-16-11	30
	CLAYEY SAND WITH GRAVEL (SC) **Dense to very dense, tan**					15-12-28 N=40							
			10			4.5 tsf (HP)							
13.0	742+/-												
	FAT CLAY (CH) **Hard, tan to light gray, shaley**					4.5 tsf (HP)	UC	2.24	5	17	107	63-19-44	
			15										
						4.5 tsf (HP)							
20.0	735+/-		20										
	Boring Terminated at 20 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry Augered 0 to 20 feet

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

Boring Started: 08-21-2018 | Boring Completed: 08-21-2018

Drill Rig: Mobile B-59 | Driller: Core Tech Drilling, Inc.

Project No.: 96175283 | Exhibit: A-13

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

APPENDIX B

LABORATORY TESTING

Laboratory Testing

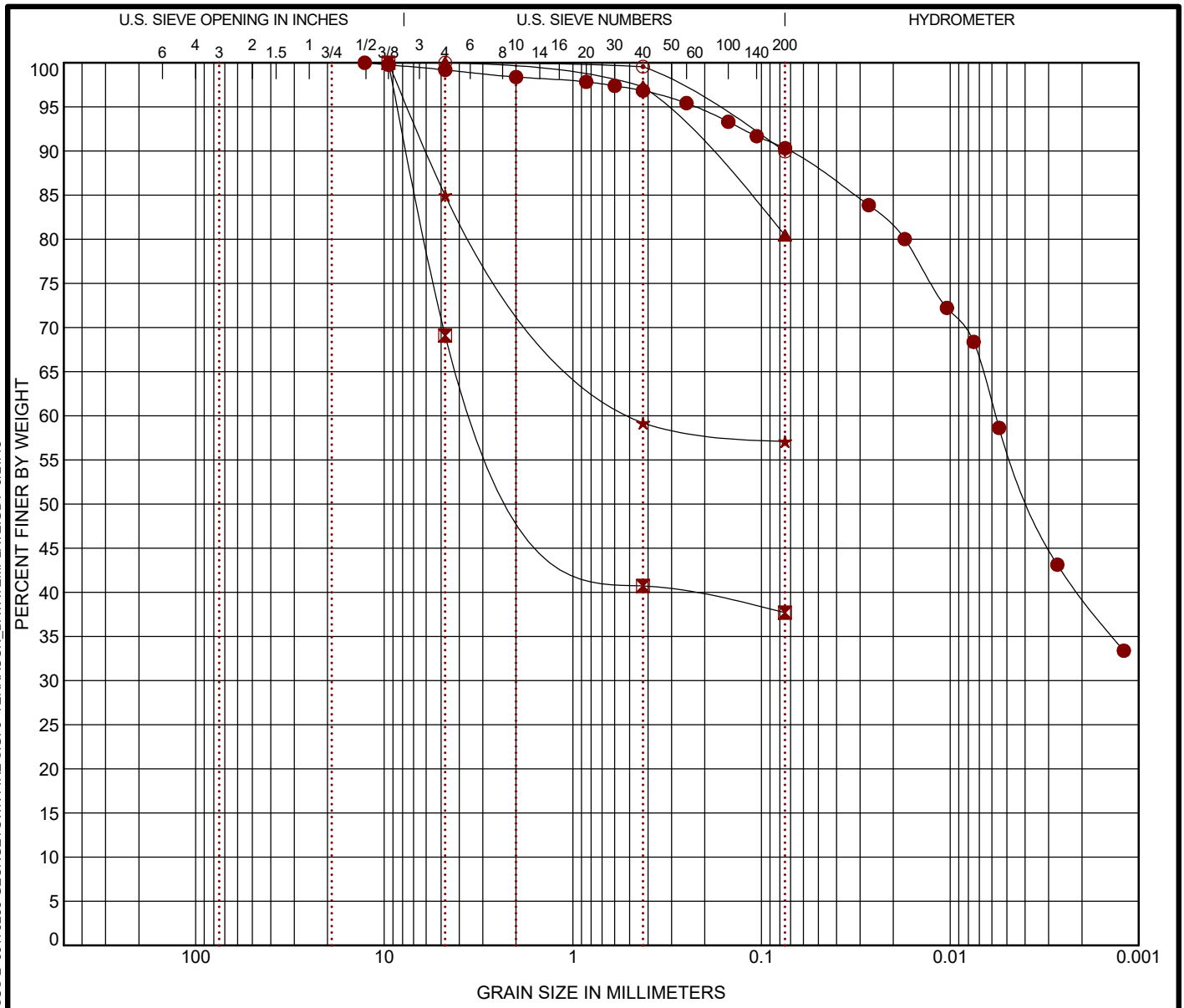
Samples obtained during the field program were visually classified in the laboratory by a geotechnical engineer. A testing program was conducted on selected samples, as directed by the geotechnical engineer, to aid in classification and evaluation of engineering properties required for analyses.

Results of the laboratory tests are presented on the boring logs located in Appendix A, in Appendix B, and/or are discussed in **Section 3.0 – Subsurface Conditions** of the report. Laboratory test results were used to classify the soils encountered as generally outlined by the Unified Soil Classification System.

Samples from borings B-6 through B-10 not tested in the laboratory will be stored for a period of 30 days subsequent to submittal of this report and will be discarded after this period, unless we are notified otherwise.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-2	2 - 4	LEAN CLAY (CL)		40	17	23		
⊠	B-2	13.5 - 14.2	CLAYEY SAND with GRAVEL (SC)	5	28	18	10		
▲	B-6	4.5 - 6	SILTY CLAY with SAND (CL-ML)	10	21	15	6		
★	B-6	18.5 - 20		14					
⊙	B-7	6.5 - 8	SILTY CLAY (CL-ML)	12	21	15	6		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-2	2 - 4	12.7	0.006			0.8	8.9	33.8		56.6
⊠	B-2	13.5 - 14.2	9.5	2.191			30.9	31.4		37.7	
▲	B-6	4.5 - 6	4.75				0.0	19.6		80.4	
★	B-6	18.5 - 20	9.5	0.459			15.0	27.9		57.1	
⊙	B-7	6.5 - 8	4.75				0.0	10.1		89.9	

PROJECT: Georgetown Fire Station No. 7

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

PROJECT NUMBER: 96175283

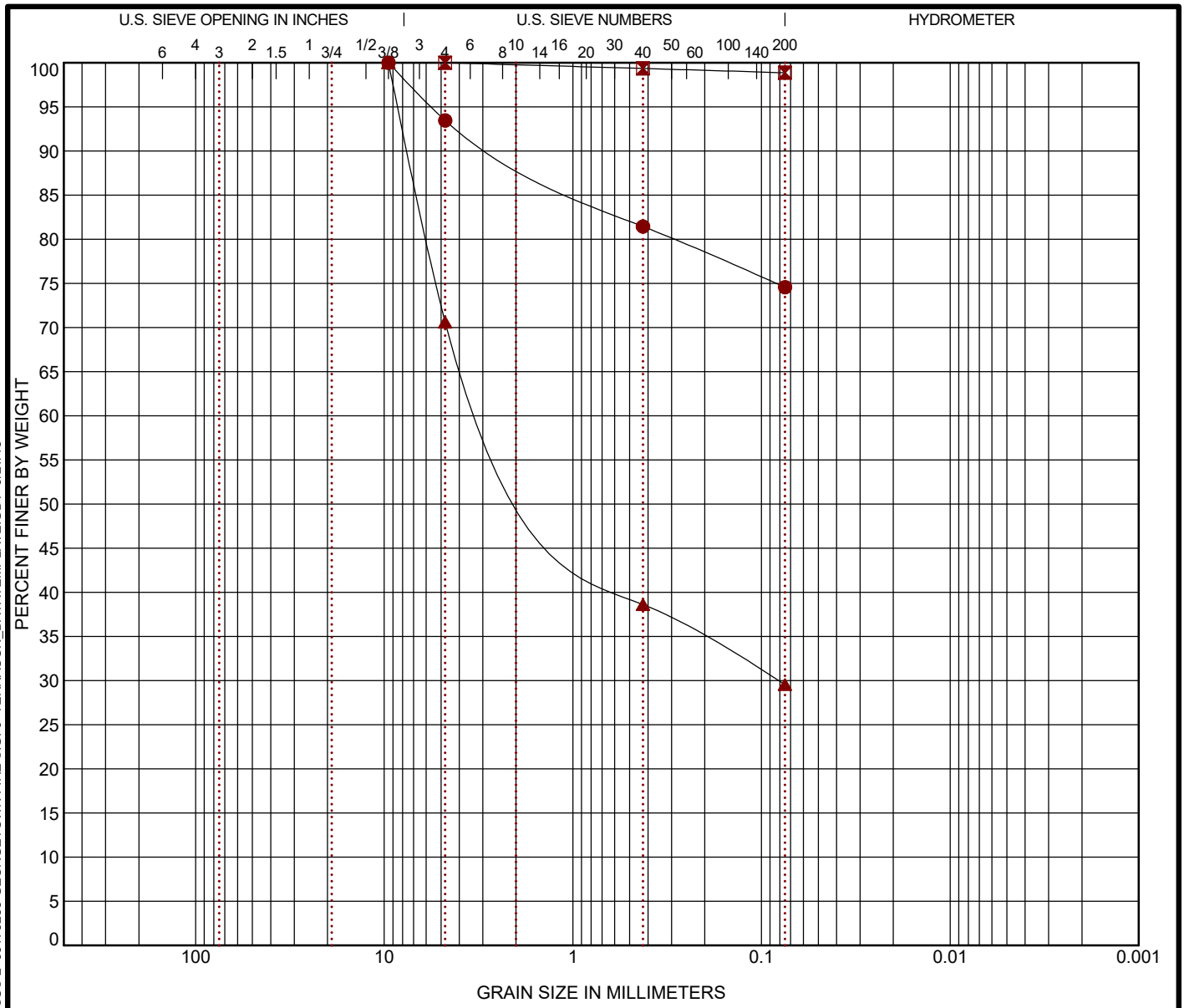
CLIENT: City of Georgetown TX
Georgetown, TX

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-8	2.5 - 4	LEAN CLAY with SAND (CL)	13	32	16	16		
⊠	B-9	8.5 - 10	FAT CLAY (CH)	21	57	17	40		
▲	B-10	4.5 - 6	CLAYEY SAND with GRAVEL (SC)	2	27	16	11		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-8	2.5 - 4	9.5				6.5	18.9		74.6	
⊠	B-9	8.5 - 10	4.75				0.0	1.1		98.9	
▲	B-10	4.5 - 6	9.5	2.134	0.082		29.4	41.1		29.5	

PROJECT: Georgetown Fire Station No. 7

SITE: E. University Avenue, W of NE Inner Loop
Georgetown, TX

Terracon
5307 Industrial Oaks Blvd, Ste 160
Austin, TX

PROJECT NUMBER: 96175283

CLIENT: City of Georgetown TX
Georgetown, TX

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 96175283 GEORGETOWN FIRE S.GPJ TERRACON_DATATEMPLATE.GDT 9/21/18

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles and/or boulders" (or both) to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

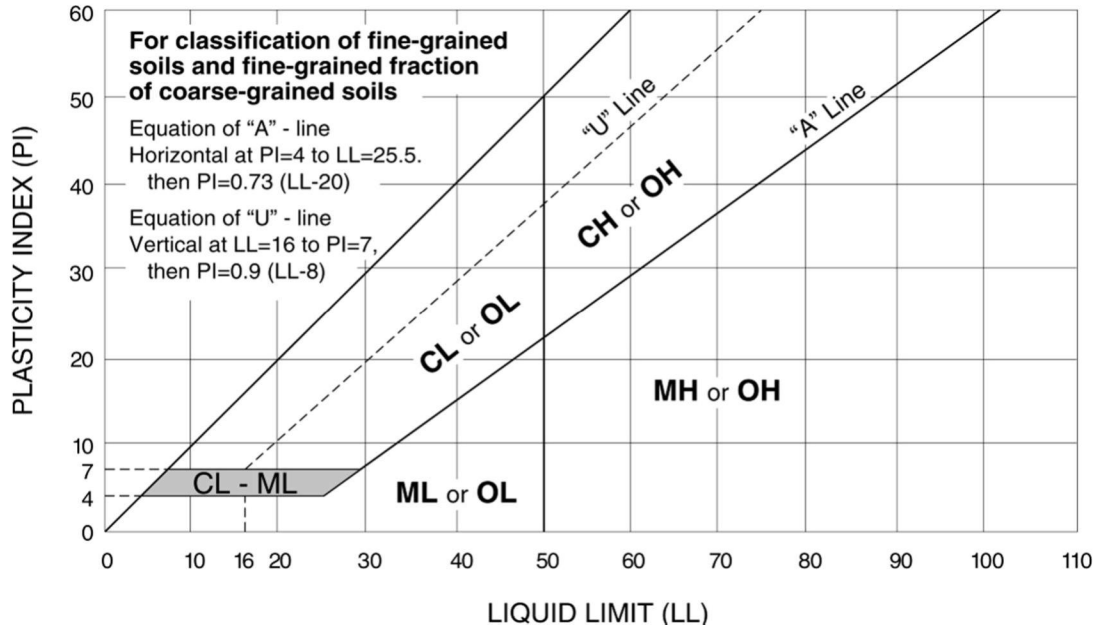
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Phase I Environmental Site Assessment

Proposed Fire Station #7

2703 East Highway 29

Georgetown, Williamson County, TX

October 25, 2017

Terracon Project No. 96177607

Prepared for:
City of Georgetown TX
Georgetown, Texas

Prepared by:
Terracon Consultants, Inc.
Austin, Texas

terracon.com

Terracon

Environmental • Facilities • Geotechnical • Materials

October 25, 2017

City of Georgetown TX
113 East 8th Street
Georgetown, TX 78626

Attn: Mr. Eric Johnson
P: (512) 819-3145
E: eric.johnson@georgetown.org

Re: Phase I Environmental Site Assessment
Proposed Fire Station #7
2703 East Highway 29
Georgetown, Williamson County, Texas
Terracon Project No. 96177607

Dear Mr. Johnson:

Terracon Consultants, Inc. (Terracon) is pleased to submit the enclosed Phase I Environmental Site Assessment (ESA) report for the above-referenced site. This assessment was performed in accordance with our Master Services Agreement for Professional Services between the City of Georgetown and Terracon dated March 25, 2016 and signed Task Order No. TCI-18-002-TO dated October 4, 2017.

We appreciate the opportunity to be of service to you on this project. In addition to Phase I services, our professionals provide geotechnical, environmental, construction materials, and facilities services on a wide variety of projects locally, regionally and nationally. For more detailed information on all of Terracon's services please visit our website at www.terracon.com. If there are any questions regarding this report or if we may be of further assistance, please do not hesitate to contact us.

Sincerely,
Terracon Consultants, Inc.

Sarah R. Schwerdfeger
Project Manager

Rhonda L. Alford
Authorized Project Reviewer/
Environmental Professional

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APPENDIX B Site Photographs
APPENDIX C Historical Documentation and User Questionnaire
APPENDIX D Environmental Database Information
APPENDIX E Credentials
APPENDIX F Description of Terms and Acronyms

EXECUTIVE SUMMARY

This Phase I Environmental Site Assessment (ESA) was performed in accordance with our Master Services Agreement for Professional Services between the City of Georgetown and Terracon dated March 25, 2016 and signed Task Order No. TCI-18-002-TO dated October 4, 2017, and was conducted consistent with the procedures included in ASTM E1527-13, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process*. The ESA was conducted under the supervision or responsible charge of Rhonda L. Alford, Environmental Professional. Sarah R. Schwerdfeger performed the site reconnaissance on October 13, 2017.

Findings and Opinions

A summary of findings is provided below. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein.

Site Description and Use

The site is an approximate 6.04-acre tract of land improved with a residence, towing and recovery company, storage yard, and automotive service shop with associated storage sheds, and unimproved drives and parking areas located at 2703 East Highway 29 in Georgetown, Williamson County, Texas. The current tenants of the site are SAS Towing & Recovery, Ralph Anderson Automotive Service, and a residence.

Historical Information

Based on a review of historical information, the site was vacant, undeveloped land from 1885 until 1941 when a residence with associated rural structures and unimproved access drive became evident. By 1976, a commercial structure with associated outbuildings and unimproved access drive and parking area became evident on the central portion of the site and remains through the present day.

The property to the north of the site was vacant, undeveloped land from 1885 and remains relatively unchanged through the present day. Residences and their associated rural structures were evident farther northeast of the site from 1925 and remains through the present day. The property to the east of the site was vacant, undeveloped land in 1885 and by 1925, Wilbarger Point road became evident. By 1941, a residence became evident east of the site and by 1974, additional residences with associated rural structures and access drives became evident and remain through the present day. The property to the south of the site was vacant, undeveloped land in 1885, and by 1925, East Highway 29 (aka East University Avenue) became evident. The property to the south was vacant, agricultural land from 1941 until 1988 when commercial structures became evident southwest of the site, and single-family residential development

became evident in 2004. The property to the west of the site was vacant, undeveloped land in 1885 and remains relatively unchanged through the present day. An unimproved drive was evident traversing the western property in a north-to-south orientation in 1995 and was revegetated by 2004.

Records Review

A review of available regulatory database information was conducted for specified federal and state agencies. Review of the regulatory databases did not identify regulated facilities on the site. The regulatory review identified one facility within the specified search distances; one TCEQ Petroleum Storage Tank (PST) facility. The facility listed in the database report does not appear to represent RECs in connection to the site at this time based upon distance from the site, apparent topographic gradient, and regulatory status.

Site Reconnaissance

No evidence of RECs was observed during the site reconnaissance.

Adjoining Properties

The property to the north and west of the site is vacant, undeveloped land. The property to the east of the site is residences with associated rural structures and access drives. The property to the south of the site is East Highway 29 (aka East University Avenue) followed by single-family residences and Saint Helen Catholic Church southwest of the site. Indications of RECs were not identified with the adjoining properties.

Additional Services

In conjunction with this ESA report, a Geologic Assessment (GA) (Terracon Project No. 96177607A) and a Cultural Resource Assessment (CR) (Terracon Project No. 96177607B) were conducted and these reports will be issued under separate cover.

Significant Data Gaps

No significant data gaps were identified.

Conclusions

We have performed a Phase I ESA consistent with the procedures included in ASTM Practice E 1527-13 at 2703 East Highway 29 in Georgetown, Williamson County, Texas, the site. Recognized Environmental Conditions (RECs) or Controlled RECs (CREC) were not identified in connection with the site.

Recommendations

Based on the scope of services, limitations, and conclusions of this assessment, Terracon did not identify RECs or CRECs. As such, no additional investigation is warranted at this time.

1.0 INTRODUCTION

1.1 Site Description

Site Name	Proposed Fire Station #7
Site Location/Address	2703 East Highway 29 in Georgetown, Williamson County, Texas
Land Area	Approximately 6.04 acres
Site Improvements	Residence, towing and recovery company, storage yard, and automotive service shop with associated storage sheds, and unimproved drives and parking areas
Anticipated Future Site Use	Fire Station
Purpose of the ESA	Acquisition

The location of the site is depicted on Exhibit 1 of Appendix A, which was reproduced from a portion of the USGS 7.5-minute series topographic map. The site and adjoining properties are depicted on the Site Diagram, which is included as Exhibit 2 of Appendix A. Acronyms and terms used in this report are described in Appendix F.

1.2 Scope of Services

This Phase I ESA was performed in accordance with our Master Services Agreement for Professional Services between the City of Georgetown and Terracon dated March 25, 2016 and signed Task Order No. TCI-18-002-TO dated October 4, 2017, and was conducted consistent with the procedures included in ASTM E1527-13, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process*. The purpose of this ESA was to assist the client in developing information to identify RECs in connection with the site as reflected by the scope of this report. This purpose was undertaken through user-provided information, a regulatory database review, historical and physical records review, interviews, including local government inquiries, as applicable, and a visual noninvasive reconnaissance of the site and adjoining properties. Limitations, ASTM deviations, and significant data gaps (if identified) are noted in the applicable sections of the report.

ASTM E1527-13 contains a new definition of "migrate/migration," which refers to “the movement of hazardous substances or petroleum products in any form, including, for example, solid and liquid at the surface or subsurface, and vapor in the subsurface.” By including this explicit reference to migration in ASTM E1527-13, the Standard clarifies that the potential for vapor migration should be addressed as part of a Phase I ESA. This Phase I ESA has considered vapor migration in evaluation of RECs associated with the site.

As requested by the client, the following additional services were performed:

- Geologic Assessment
- Cultural Resources Assessment

1.3 Standard of Care

This ESA was performed in accordance with generally accepted practices of this profession, undertaken in similar studies at the same time and in the same geographical area. We have endeavored to meet this standard of care, but may be limited by conditions encountered during performance, a client-driven scope of work, or inability to review information not received by the report date. Where appropriate, these limitations are discussed in the text of the report, and an evaluation of their significance with respect to our findings has been conducted.

Phase I ESAs, such as the one performed at this site, are of limited scope, are noninvasive, and cannot eliminate the potential that hazardous, toxic, or petroleum substances are present or have been released at the site beyond what is identified by the limited scope of this ESA. In conducting the limited scope of services described herein, certain sources of information and public records were not reviewed. It should be recognized that environmental concerns may be documented in public records that were not reviewed. No ESA can wholly eliminate uncertainty regarding the potential for RECs in connection with a property. Performance of this practice is intended to reduce, but not eliminate, uncertainty regarding the potential for RECs. No warranties, express or implied, are intended or made. The limitations herein must be considered when the user of this report formulates opinions as to risks associated with the site or otherwise uses the report for any other purpose. These risks may be further evaluated – but not eliminated – through additional research or assessment. We will, upon request, advise you of additional research or assessment options that may be available and associated costs.

1.4 Additional Scope Limitations, ASTM Deviations and Data Gaps

Based upon the agreed-on scope of services, this ESA did not include subsurface or other invasive assessments, vapor intrusion assessments or indoor air quality assessments (i.e. evaluation of the presence of vapors within a building structure), business environmental risk evaluations, or other services not particularly identified and discussed herein. Credentials of the company (Statement of Qualifications) have not been included in this report but are available upon request. Pertinent documents are referred to in the text of this report, and a separate reference section has not been included. Reasonable attempts were made to obtain information within the scope and time constraints set forth by the client; however, in some instances, information requested is not, or was not, received by the issuance date of the report. Information obtained for this ESA was received from several sources that we believe to be reliable; nonetheless, the authenticity or reliability of these sources cannot and is not warranted hereunder. This ESA was further limited by the following:

- Due to dense vegetation, parts of the northern portion of the site could not be accessed and surface conditions could not be observed.
- A written request was submitted to the local government agency regarding documented RECs on the site. Records were not requested for off-site properties.
- At the time of the site reconnaissance, the on-site residence and SAS Towing & Recovery office was locked and inaccessible.
- At the time of the site reconnaissance, some of the storage sheds were locked and inaccessible.

An evaluation of the significance of limitations and missing information with respect to our findings has been conducted, and where appropriate, significant data gaps are identified and discussed in the text of the report. However, it should be recognized that an evaluation of significant data gaps is based on the information available at the time of report issuance, and an evaluation of information received after the report issuance date may result in an alteration of our conclusions, recommendations, or opinions. We have no obligation to provide information obtained or discovered by us after the issuance date of the report, or to perform any additional services, regardless of whether the information would affect any conclusions, recommendations, or opinions in the report. This disclaimer specifically applies to any information that has not been provided by the client.

This report represents our service to you as of the report date and constitutes our final document; its text may not be altered after final issuance. Findings in this report are based upon the site's current utilization, information derived from the most recent reconnaissance and from other activities described herein; such information is subject to change. Certain indicators of the presence of hazardous substances or petroleum products may have been latent, inaccessible, unobservable, or not present during the most recent reconnaissance and may subsequently become observable (such as after site renovation or development). Further, these services are not to be construed as legal interpretation or advice.

1.5 Reliance

This ESA report is prepared for the exclusive use and reliance of City of Georgetown TX. Use or reliance by any other party is prohibited without the written authorization of City of Georgetown TX and Terracon Consultants, Inc. (Terracon).

Reliance on the ESA by the client and all authorized parties will be subject to the terms, conditions and limitations stated in the proposal, ESA report, and Terracon's Master Services Agreement. The limitation of liability defined in the Master Services Agreement is the aggregate limit of Terracon's liability to the client and all relying parties.

Continued viability of this report is subject to ASTM E1527-13 Sections 4.6 and 4.8. If the ESA will be used by a different user (third party) than the user for whom the ESA was originally

prepared, the third party must also satisfy the user's responsibilities in Section 6 of ASTM E1527-13.

1.6 Client Provided Information

Prior to the site visit, Mr. Eric Johnson, client's representative, provided the following user questionnaire information as described in ASTM E1527-13 Section 6.

Client Questionnaire Responses

Client Questionnaire Item	Client Did Not Respond	Client's Response	
		Yes	No
Specialized Knowledge or Experience that is material to a REC in connection with the site.			X
Actual Knowledge of Environmental Liens or Activity Use Limitations (AULs) that may encumber the site.			X
Actual Knowledge of a Lower Purchase Price because contamination is known or believed to be present at the site.			X
Commonly Known or Reasonably Ascertainable Information that is material to a REC in connection with the site.			X
Obvious Indicators of Contamination at the site.			X

Terracon's consideration of the client provided information did not identify RECs. A copy of the questionnaire is included in Appendix C.

2.0 PHYSICAL SETTING

Physical Setting Information		Source
Topography		
Site Elevation	Approximately 750 to 760 feet above sea level	USGS Topographic Map, Georgetown, Texas Quadrangle, 1982
Topographic Gradient	Gently sloping towards the north	
Closest Surface Water	Unnamed tributary of Smith Branch, along the northern boundary of the site	

Soil Characteristics		
Soil Type	Krum silty clay, 0 to 1 percent slopes (**KsA**), Sunev silty clay loam, 1 to 3 percent slopes (**SuB**), Heiden clay, 5 to 8 percent slopes, eroded (**HeD2**)	Williamson County, TX USDA, Soil Conservation Services Soil Survey issued 1983
Description	**KsA**- This nearly level soil is on high terraces. This soil is well drained. Runoff is slow, and permeability is moderately slow. The available water capacity is high. Plant roots easily penetrate the soil. Erosion is a slight hazard. Corrosivity of underground steel pipe is high. **SuB**- This gently sloping soil is on stream terraces below areas of the nearly level Sunev soil. This soil is well drained. Permeability id moderate. Runoff is medium. The available water capacity is moderate. Roots easily penetrate this soils. Erosion is a slight hazard. For urban uses, corrosion of underground pipe is a moderate limitation that can be controlled. **HeD2**- This series consists of well-drained, deep, clay soils that developed in calcareous marl. Available water capacity is high. These soils crack when dry. When they are wet, the cracks close and permeability is very slow (<0.06 inches per hour). The risk of corrosion to uncoated steel is high.	

Geology/Hydrogeology		
Formation	Eagle Ford Group (Kef)	"Austin Sheet," Geologic Atlas of Texas, Bureau of Economic Geology, The University of Texas at Austin, 1974
Description	Shale, siltstone, and limestone; upper part limestone and shale, limestone light yellowish brown, flaggy; lower part siltstone and very fine-grained sandstone, light yellow to gray, laminated, flaggy, some limestone, silty, medium brown, laminated	
Estimated Depth to First Occurrence of Groundwater	Approximately 25 to 30 feet bgs	Terracon's Experience
Primary Aquifer	Trinity Group and Edwards Aquifer (Within the Edwards Aquifer Transition zone)	Groundwater Quality of Texas – An Overview of Natural and Man-Affected Conditions, Texas Water Commission, 1989
*Hydrogeologic Gradient	Not known - may be inferred to be parallel to topographic gradient (primarily to the north).	

* The groundwater flow direction and the depth to shallow, unconfined groundwater, if present, would likely vary depending upon seasonal variations in rainfall and other hydrogeological features. Without the benefit of on-site groundwater monitoring wells surveyed to a datum, groundwater depth and flow direction beneath the site cannot be directly ascertained.

3.0 HISTORICAL USE INFORMATION

Terracon reviewed the following historical sources to develop a history of the previous uses of the site and surrounding area, in order to help identify RECs associated with past uses. Copies of selected historical documents are included in Appendix C.

3.1 Historical Topographic Maps, Aerial Photographs, Sanborn Maps

Readily available historical USGS topographic maps and selected historical aerial photographs (at approximately 10 to 15 year intervals) were reviewed to evaluate land development and obtain information concerning the history of development on and near the site. Reviewed historical topographic maps and aerial photographs are summarized below.

Historical fire insurance maps produced by the Sanborn Map Company were requested from GeoSearch to evaluate past uses and relevant characteristics of the site and surrounding properties. Based upon inquiries to the above-listed Sanborn provider, Sanborn maps were not available for the site.

- Topographic map: Georgetown, Texas Quadrangle, published in 1885, 1"=10,420'
- Topographic map: Round Rock, Texas Quadrangle, published in **1925**, 1"=5,208'

- Aerial photograph: Agricultural Stabilization and Conservation Service (ASCS), Frame: 11-20, **1941**, 1"=400'
- Topographic map: Round Rock, Texas Quadrangle, published in **1949**, 1"=5,208'
- Aerial photograph: Army Mapping Service (AMS), Frame: 2145, **1953**, 1"=400'
- Aerial photograph: ASCS, Frame: PI-2, **1958**, 1"=400'
- Aerial photograph: ASCS, Frame: PI-6, **1964**, 1"=400'
- Aerial photograph: United States Geologic Survey (USGS), Frame: 2-175, **1974**, 1"=400'
- Topographic map: Round Rock, Texas Quadrangle, published in **1976**, 1"=4,167'
- Aerial photograph: Texas Department of Transportation (TXDOT), Frame: 2-47, **1981**, 1"=400'
- Topographic map: Georgetown, Texas Quadrangle, published in **1982**, 1"=2,000'
- Aerial photograph: TXDOT, Frame: 12-245, **1988**, 1"=400'
- Aerial photograph: USGS, Frame: N/A, **1995**, 1"=400'
- Aerial photograph: United States Department of Agriculture (USDA), Frame: N/A, **2004**, 1"=400'
- Aerial photograph: USDA, Frame: N/A, **2014**, 1"=400'

Historical Topographic Maps and Aerial Photographs

Direction	Description
Site	Vacant, undeveloped land (1885-1925); residence with associated rural structures and unimproved access drive (1941-1974); commercial structure with associated outbuildings and unimproved access drive and parking area (1976-2014)
North	Vacant, undeveloped land (1885-2014); residences and associated rural structures farther northeast of the site (1925-2014)
East	Vacant, undeveloped land (1885); Wilbarger Point road (1925-2014); residence (1941-2014); additional residences with associated rural structures and access drives (1974-2014)
South	Vacant, undeveloped land (1885); East Highway 29 (East University Avenue) (1925-2014); vacant, agricultural land (1941-1982); commercial structures southwest of the site (1988-2014); single-family residential development (2004-2014)
West	Vacant, undeveloped land (1885-2014); unimproved drive (1995)

3.2 Historical City Directories

The Cole and Polk city directories and InfoUSA database used in this study were made available through GeoSearch (selected years reviewed: 1985-2016) and were reviewed at approximate five-year intervals, if readily available. Since these references are copyright protected, reproductions are not provided in this report. Street listings were not available prior to 1985. The current street address for the site was identified as 2703 East Highway 29.

Historical City Directories

Direction	Description
Site	**2703 East Highway 29:** No listings (1985/86, 1990/91, 2011-2015); J & P Enterprises (2001/02); Anderson Ralph Automotive Service, Bohanan Towing, and residence (2006)
North	No listings
East	**103 Wilbarger Point:** No listings (1990/92-2001/02, 2011-2015); residence (2006) **105 Wilbarger Point:** No listings (1990-1995/96, 2011-2015); 109 (2001/02); residence (2006) **2717 East Highway 29:** No listings (1985/86-2001/02, 2011-2015); Fletchers Ranch & Garden Center (2006) **2719 East Highway 29:** No listings (1985/86-1995/96); residence (2001/02, 2006, 2011, 2015)
South	**1102 Ascot Street:** No Listing (1997/98-2001/02); residence (2006, 2011, 2016) **1108 Ascot Street:** No Listing (1997/98-2001/02, 2011, 2016); residence (2006) **1114 Ascot Street:** No Listing (1997/98-2001/02, 2011); residence (2006, 2016) **1120 Ascot Street:** No Listing (1997/98-2001/02, 2011); residence (2006, 2016) **1126 Ascot Street:** No Listing (1997/98-2001/02, 2016); residence (2006) **1132 Ascot Street:** No Listing (1997/98-2001/02); residence (2006, 2011, 2016) **1138 Ascot Street:** No Listing (1997/98-2001/02, 2006-2016) **1142 Ascot Street:** No Listing (1997/98-2001/02); residence (2006, 2011, 2016) **2700 East Highway 29:** Our Lady-the Rosary Cemetery, St. Helen Catholic School, St. Helen's Catholic Church (1995/96, 2006, 2011, 2015); Knights Clmbs Cncl, St. Hln Cath Ch Ofc (2001/02); St. Helens Cthic Ch, St. Helens Prsh Hl, residence (1985/86-1990/91) **2850 East Highway 29:** No listings (1985/86-2001/02); Adt Authorized Dealer, Atm, ***Jiffy Mart No 6*** (2006, 2011, 2015)
West	No listings

Please refer to Section 4.1 for further discussion of Jiffy Mart No 6 facility.

3.3 Site Ownership

Based on a review of information obtained from the Williamson Central Appraisal District website, the current site owner is listed as James E. Robinson TR of the James E. Robinson Family Trust. No previous owners were listed.

3.4 Title Search

At the direction of the client, a title search was not included as part of the scope of services. Unless notified otherwise, we assume that the client is evaluating this information outside the scope of this report.

3.5 Environmental Liens and Activity and Use Limitations

The GeoSearch regulatory database report included a review of both Federal and State Engineering Control (EC) and Institutional Control (IC) databases. Based on a review of the database report, the site was not listed on the EC or IC databases. Please note that in addition to these federal and state listings, AULs can be recorded at the county and municipal level that may not be listed in the regulatory database report. Environmental lien and activity and use limitation records recorded against the site were not provided by the client. At the direction of the client, performance of a review of these records was not included as part of the scope of services and unless notified otherwise, we assume that the client is evaluating this information outside the scope of this report.

3.6 Interviews Regarding Current and Historical Site Uses

The following individuals were interviewed regarding the current and historical use of the site.

Interviews

Interviewer	Name / Phone #	Title	Date/Time
Sarah R. Schwerdfeger	Mr. Jody Robinson/(512) 844-9687	Current Site Owner	October 24, 2017
Sarah R. Schwerdfeger	Mr. Ralph Anderson/(512) 869-4057	Owner of automotive service shop	October 23, 2017
Sarah R. Schwerdfeger	Mr. Jeremy (surname not given)/(512) 705-9393	Owner of SAS Towing & Recovery	October 24, 2017

Terracon interviewed Mr. Jody Robinson, current site owner, following the site reconnaissance. Mr. Robinson indicated that he and his family have owned the site since 2003. Mr. Robinson indicated that the site was used as a headquarter for a nearby farming operation. Mr. Robinson confirmed the current tenants on the site and indicated that he was unaware of any other businesses operating on the site. Mr. Robinson was unaware of any underground storage tanks, irrigation systems, monitoring wells, landfill or quarrying activity, or hazardous waste activities on the site. Mr. Robinson noted that the small concrete slab behind the SAS Towing & Recovery office was a small shed that was removed. Mr. Robinson was unaware of any pending, threatened, or past litigation, administrative proceeding, or notice of environmental law violations relevant to hazardous substances or petroleum products in, on, or from the site.

Terracon also interview Mr. Ralph Anderson, owner of the on-site automotive service shop during and following the site reconnaissance. Mr. Anderson indicated he had been affiliated with the site for approximately twelve years. Mr. Anderson noted that the two chemical totes in the barn and large shipping container near the automotive service shop belongs to a third party that owns and operates a portable bathroom facility business. The remaining two chemical totes located in the storage yard belong to SAS Towing & Recovery, and Mr. Anderson was unaware of their contents, if any. A hollow-sounding area was observed on the northern portion of the site

and behind the barn during the site reconnaissance. Mr. Anderson was unaware of area but noted that there were several barn structures in the vicinity of the hollow-sounding area behind the existing barn at one time.

Terracon also interviewed Jeremy, owner of SAS Towing & Recovery, following the site reconnaissance. Jeremy indicated that their two portable sheds contained chains, power tools, and new fluids for the towing trucks. Jeremy also noted that the two chemical totes located in the storage yard area were empty.

3.7 Prior Report Review

Terracon requested the client provide any previous environmental reports they are aware of for the site. Previous reports were not provided by the client to Terracon for review.

4.0 RECORDS REVIEW

Regulatory database information was provided by GeoSearch, a contract information services company. The purpose of the records review was to identify RECs in connection with the site. Information in this section is subject to the accuracy of the data provided by the information services company and the date at which the information is updated. The scope herein did not include confirmation of facilities listed as "unmappable" by regulatory databases.

In some of the following subsections, the words up-gradient, cross-gradient and down-gradient refer to the topographic gradient in relation to the site. As stated previously, the groundwater flow direction and the depth to shallow groundwater, if present, would likely vary depending upon seasonal variations in rainfall and the depth to the soil/bedrock interface. Without the benefit of on-site groundwater monitoring wells surveyed to a datum, groundwater depth and flow direction beneath the site cannot be directly ascertained.

4.1 Federal and State/Tribal Databases

Listed below are the facility listings identified on federal and state/tribal databases within the ASTM-required search distances from the approximate site boundaries. Database definition, descriptions, and the database search report are included in Appendix D.

Federal Databases

Database	Description	Distance (miles)	Listings
BF	Brownfields Management System	0.5	0
SEMS	Superfund Enterprise Management System (formerly CERCLIS)	0.5	0
DNPL	Delisted National Priorities List	1.0	0

Database	Description	Distance (miles)	Listings
EC	Federal Engineering Institutional Control Sites	Site	0
ERNSTX	Emergency Response Notification System	Site	0
LUCIS	Land Use Control Information System	0.5	0
SEMSARCH	SEMS Archived Sites (formerly CERCLIS-NFRAP)	0.5	0
NLRRCRAG	No Longer Regulated RCRA Generator Facilities	0.1	0
NLRRCRAT	No Longer Regulated RCRA Non-CORRACTS TSD Facilities	0.5	0
NPL	National Priorities List	1.0	0
PNPL	Proposed National Priorities List	1.0	0
RCRAC	Resource Conservation & Recovery Act - Corrective Action Facilities	1.0	0
RCRAT	Resource Conservation & Recovery Act - Treatment Storage & Disposal Facilities	0.5	0

State/Tribal Databases

Database	Description	Distance (miles)	Listings
LUSTR06	Leaking Underground Storage Tanks On Tribal Lands (Region 6 States)	0.5	0
TXAPAR	Affected Property Assessment Reports	0.5	0
TXBSA	Brownfields Site Assessments	0.5	0
TXCALF	Closed & Abandoned Landfill Inventory	0.5	0
TXDCR	Dry Cleaner Registration Database	0.25	0
TXDCRPS	Dry Cleaner Remediation Program Sites	0.5	0
TXGWCC	Groundwater Contamination Cases	Site	0
TXHISTGWCC	Historic Groundwater Contamination Cases	Site	0
TXIHW	Industrial And Hazardous Waste Sites	0.1	0
TXIHWCA	Industrial And Hazardous Waste Corrective Action Sites	1.0	0
TXIOP	Innocent Owner / Operator Database	0.5	0
TXLIENS	TCEQ Liens	Site	0
TXLPST	Leaking Petroleum Storage Tanks	0.5	0
TXMSD	Municipal Setting Designations	Site	0
TXMSWLF	Municipal Solid Waste Landfill Sites	0.5	0
TXNOV	Notice Of Violations	Site	0
TXPIHW	Permitted Industrial Hazardous Waste Sites	0.1	0
TXPST	Petroleum Storage Tanks	0.1	1
TXRRCVCP	Railroad Commission VCP And Brownfield Sites	0.5	0
TXRWS	Radioactive Waste Sites	0.5	0
TXSF	State Superfund	1.0	0

Database	Description	Distance (miles)	Listings
TXSIEC01	State Institutional/Engineering Control Sites	Site	0
TXSPILLS	Spills Listing	Site	0
TXTIERII	Tier I I Chemical Reporting Program Facilities	0.5	0
TXVCP	Voluntary Cleanup Program	0.5	0
TXWMRF	Recycling Facilities	0.5	0
USTR06	Underground Storage Tanks On Tribal Lands (Region 6 States)	0.1	0

In addition to the above ASTM-required listings, Terracon reviewed other federal, state, local, and proprietary databases provided by the database firm. A list of the additional reviewed databases is included in the regulatory database report included in Appendix D.

The following table summarizes the site-specific information provided by the database and/or gathered by this office for identified facilities. Facilities are listed in order of proximity to the site. Additional discussion for selected facilities follows the summary table.

Listed Facilities

Facility Name and Location	Estimated Distance / Direction/Gradient	Database Listings	Is a REC, CREC, or HREC to the Site
Jiffy Mart 6 2850 East University Avenue	Approximately 350 feet/southeast/ cross-gradient	PST	No, discussed below

Jiffy Mart 6

Jiffy Mart 6 is listed as a TCEQ PST facility located approximately 350 feet southeast (across East Highway 29) of the site and topographically cross-gradient relative to the site. Based on the regulatory database information, this facility operates one 12,000-gallon gasoline tank and one compartmentalized 6,000/6,000-gallon, gasoline/diesel tank. Both tanks are double-walled, fiberglass reinforced plastic (FRP) and were reportedly installed in 1996. During the area reconnaissance, the tank-hold was observed approximately 500 feet southeast of the site. Tank release detection methods are achieved via interstitial monitoring within secondary wall/jacket, automatic tank gauge test, and inventory control. Pipe release detection methods are achieved via annual piping tightness test/annual electronic monitoring, and automatic line leak detector. Spill/overfill protection requirements are met via factory-built spill container/bucket/sump, and tight-fill fitting container/bucket/sump, and delivery shut-off valves. Based on the distance from the site, topographic gradient relative to the site, and regulatory status (Non-LPST), this facility does not appear to constitute a REC in connection to the site at this time.

Unmapped facilities are those that do not contain sufficient address or location information to evaluate the facility listing locations relative to the site. The report did not list facilities in the unmapped section.

4.2 Local Agency Inquiries

Agency Contacted/ Contact Method	Response
Texas Department of State Health Services / email	The Texas Department of State Health Services was contacted by letter regarding environmental records or information indicating environmental concerns for the site. At the issuance of this report, a response stated, "Based on the information you have provided, no records exist at this time."
City of Georgetown / Online Open Records Request	At the issuance of this report, a response from the City of Georgetown has not been received.

4.3 Local Area Knowledge

4.3.1 Closed Landfill Inventory (CLI)

The Closed Landfill Inventory (CLI) for Williamson County, available on the Capital Area Council of Government website (www.capcog.org), was reviewed to identify unauthorized/unpermitted landfills within the general site vicinity. The review did not identify any documented landfills within the 0.5-mile search distance.

4.3.2 Zoning/Land Use Records

According to the City of Georgetown website, a portion of the site is zoned as Residential Single-Family (RS) and the remainder of the site is zoned as Extra Territorial Jurisdiction (ETJ).

5.0 SITE RECONNAISSANCE

5.1 General Site Information

Information contained in this section is based on a visual reconnaissance conducted while walking through the site and the accessible interior areas of structures, if any, located on the site. Exhibit 2 in Appendix A is a Site Diagram of the site. Photo documentation of the site at the time of the visual reconnaissance is provided in Appendix B. Credentials of the individuals planning and conducting the site visit are included in Appendix E.

General Site Information

Site Reconnaissance	
Field Personnel	Sarah R. Schwerdfeger
Reconnaissance Date	October 13, 2017
Weather Conditions	Warm and Sunny
Site Contact/Title	Mr. Eric Johnson/(512) 844-9687

Building Description				
Building Identification	**Building Use**	**Approx. Construction Date**	**Number of Stories**	**Approx. Size (ft²)**
Residence	Residence	1940s	1	2,000
Automotive Service Shop	Automotive maintenance/repair	1980s	1	3,600
SAS Towing & Recovery Office	Office	1980s	1	750

Site Utilities	
Drinking Water	Jonah Water
Electric	Encore

5.2 Overview of Current Site Occupants

The site is currently occupied by a residence, SAS Towing & Recovery, and Ralph Anderson Automotive Service.

5.3 Overview of Current Site Operations

The site currently operates as a residence, towing and recovery company, and an automotive service shop.

5.4 Site Observations

The following table summarizes site observations and interviews. Affirmative responses (designated by an “X”) are discussed in more detail following the table.

Site Characteristics

Category	Item or Feature	Observed or Identified
Site Operations, Processes, and Equipment	Emergency generators	
	Elevators	
	Air compressors	X

Category	Item or Feature	Observed or Identified
	Hydraulic lifts	X
	Dry cleaning	
	Photo processing	
	Ventilation hoods and/or incinerators	
	Waste treatment systems and/or water treatment systems	
	Heating and/or cooling systems	
	Paint booths	
	Sub-grade mechanic pits	
	Wash-down areas or carwashes	
	Pesticide/herbicide production or storage	
	Printing operations	
	Metal finishing (e.g., electroplating, chrome plating, galvanizing, etc.)	
	Salvage operations	
	Oil, gas or mineral production	
	Other processes or equipment	X
Aboveground Chemical or Waste Storage	Aboveground storage tanks	X
	Containers ≥ 5 gallons	X
	MSDS or SDS	
Underground Chemical or Waste Storage, Drainage or Collection Systems	Underground storage tanks or ancillary UST equipment	
	Sumps, cisterns, French drains, catch basins and/or dry wells	
	Grease traps	
	Septic tanks and/or leach fields	X
	Oil/water separators, clarifiers, sand traps, triple traps, interceptors	
	Pipeline markers	
	Interior floor drains	
Electrical Transformers/ PCBs	Transformers and/or capacitors	X
	Other equipment	

Category	Item or Feature	Observed or Identified
Releases or Potential Releases	Stressed vegetation	
	Stained soil	
	Stained pavement or similar surface	X
	Leachate and/or waste seeps	
	Trash, debris and/or other waste materials	X
	Dumping or disposal areas	
	Construction/demolition debris and/or dumped fill dirt	
	Surface water discoloration, odor, sheen, and/or free floating product	
	Strong, pungent or noxious odors	
	Exterior pipe discharges and/or other effluent discharges	
Other Notable Site Features	Surface water bodies	
	Quarries or pits	
	Wastewater lagoons	
	Wells	X

Site Operations, Processes, and Equipment

Air compressors

Two air compressors were observed during the site reconnaissance; one located on concrete outside, and one located on concrete inside the automotive service shop. Surficial staining and releases were observed beneath the air compressor outside of the automotive service shop at the time of the site reconnaissance. Please see below (Stained pavement or similar surfaces) for further discussion of the observed concrete staining.

Hydraulic lifts

Two aboveground hydraulic lifts were observed in the automotive service shop during the site reconnaissance. The units did not appear to have subsurface components. According to the automotive service shop owner, Mr. Ralph Anderson, he was not aware of any in-ground hydraulic lifts. Staining and/or hydraulic fluid releases assoicated with the lifts were not observed at the time of the site reconnaissance. Although portions of the floor of the service shop was covered with equipment and parts, no evidence of prior in-ground hydraulic lifts were observed.

Other processes or equipment

At the time of the site reconnaissance, new and used automotive batteries were observed on a wire rack over the concrete floor within the automotive service shop. According to Mr. Ralph Anderson, the used batteries are removed from the site by Interstate Battery. No releases,

staining or discoloration was observed in the vicinity of the batteries at the time of the site reconnaissance.

At the time of the site reconnaissance, two compressed gas cylinders were observed within the automotive service shop. According to Mr. Anderson, these compressed gas cylinders contain chemicals used for welding (likely oxygen and acetylene). Mr. Anderson further indicated that a contracted company maintains the compressed gas cylinders.

According to Mr. Anderson, the shop rags and uniforms are collected in a metal container within the shop area and taken off-site by UniFirst for cleaning.

At the time of the site reconnaissance, Mr. Anderson indicated that tire services were provided at the shop at one time. Numerous used tires were observed throughout the site and in the automotive service shop. According to Mr. Anderson, they no longer provide tire services and will be disposing of the used tires. Please note tires are considered a special waste and may have specific disposal requirements. All tires should be removed from the site and disposed of in accordance with applicable regulations.

Additionally, one parts washer was observed over concrete in the automotive service shop area at the time of the site reconnaissance. According to Mr. Anderson, the parts washer is serviced every four to six months by Safety-Kleen and uses NAPTHA based chemicals. No evidence of releases, staining, or floor drains were observed in the vicinity of the parts washer at the time of the site reconnaissance. If not intended for future use, the parts washer should be removed and the cleaning solution disposed of in accordance with applicable regulations.

Aboveground Chemical or Waste Storage

Aboveground storage tanks

At the time of the site reconnaissance, numerous 55-gallon drums, four 250-gallon chemical totes, and several plastic water storage containers were observed throughout the site and automotive service shop. According to Mr. Anderson, these drums and aboveground storage tanks (ASTs) contain(ed) used motor oil, antifreeze, degreasers, or water. Additionally, Mr. Anderson indicated that several different contracted companies dispose of the used products (i.e. oil filters, motor oil, antifreeze etc.) off-site. No evidence of releases, staining or discoloration, or distressed vegetation was observed in the vicinity of the drums or ASTs at the time of the site reconnaissance. Any spent automotive fluids and waste generated should be removed and disposed of in accordance with applicable regulations.

Containers ≥ 5 gallons

Several 5-gallon buckets and numerous containers of varying sizes were observed throughout the site and within the automotive service shop at the time of the site reconnaissance. According to the Mr. Anderson, the buckets and containers contain used motor oil, antifreeze, water, gasoline, or are empty, and the spent/waste fluids are disposed of off-site by a contracted

service. The observed buckets and containers were in good condition and were not observed within secondary containment. No evidence of releases, staining, or floor drains were observed in the vicinity of the 5-gallon buckets or containers at the time of the site reconnaissance. Any spent automotive fluids and waste generated should be removed and disposed of in accordance with applicable regulations.

Underground Chemical or Waste Storage, Drainage or Collection Systems

Septic tanks and/or leach fields

Mr. Robinson indicated that one septic system, used for residential purposes, was located behind the residence and SAS Towing & Recovery office. Mr. Robinson was unaware of the location of the leach field. The on-site septic system was not observed during the site reconnaissance; however, the septic system present on the site does not appear to constitute a REC based on the residential nature of its use; however, if no further use is intended, the septic system should be removed and/or closed in accordance with applicable regulations.

Electrical Transformers/ PCBs

Transformers and/or capacitors

During Terracon's site reconnaissance, four pole-mounted transformers (non-labeled), owned and serviced by Encore, were observed on the southwest corner and central and northern portions of the site. Some transformers contain mineral oil which may contain PCBs. There was no evidence of leakage noted at the time of the site reconnaissance. Encore has acknowledged responsibility for cleanup of PCB or non-PCB spills for the transformers. Based on this information, the on-site transformers do not appear to constitute a REC in connection with the site.

Releases or Potential Releases

Stained pavement or similar surface

Concrete staining was observed throughout the automotive service shop and near the air compressor outside of the automotive service shop at the time of the site reconnaissance. According to Mr. Anderson, whenever a spill occurs, either clay absorbent material is placed on the spill or the spill is wiped up with a shop rag which are picked up and disposed of off-site by a contracted company. Based on the minimal nature of the releases and the relatively low impervious nature of concrete, the staining appears to be a *de minimis* condition that does not constitute a REC in connection with the site at this time.

Trash, debris and/or other waste materials

One solid waste disposal dumpster (managed by Texas Disposal Systems) was observed on the western-central portion of the site. No evidence of staining, noxious odors or hazardous waste disposal was observed within or in the vicinity of the on-site dumpster at the time of the site reconnaissance.

Debris was observed throughout the northern and eastern portions of the site during the site reconnaissance. The debris material consisted of: used tires, mulch bags, lumber, pieces of metal, brush piles, a flatbed trailer, car parts, and plastic piping. Leakage, spills or other releases from these materials were not observed during the site reconnaissance, and the debris should be removed and disposed of in accordance with applicable regulations prior to site development.

In addition, what appeared to be a sheet of wood or metal with equally spaces holes was observed behind the barn and almost completely covered with vegetation and debris making visibility of the feature very limited. When walking on this feature, it sounded hollow below. Mr. Anderson was not aware of its prior use or purpose. No evidence of surficial staining, distressed vegetation, or noxious odors were noted on or within the vicinity of this feature during the site reconnaissance. During future site development, this feature should be removed and impacted media, if any, should be characterized, removed, and disposed of in accordance with applicable regulations.

Other Notable Site Features

Wells

One water well was observed on the north-central portion of the site during the site reconnaissance. The water well was located in a small wooden shed and had no noxious odors emanating from around the structure at the time of the site reconnaissance. According to Mr. Anderson, the water well is normally dry and is not used; but due to recent rains, the well water is used in the automotive service shop sinks (hand washing). When no further use is intended, the water well should be properly plugged and abandoned in accordance with applicable regulations prior to site development. If the well is to be used as a potable water source, the future site owners should consider having the water tested by a licensed laboratory to evaluate the water quality.

6.0 ADJOINING PROPERTY RECONNAISSANCE

Visual observations of adjoining properties (from site boundaries) are summarized below.

Adjoining Properties

Direction	Description
North	Vacant, undeveloped land
East	Residences with associated rural structures and access drives
South	East Highway 29 (East University Avenue) followed by single-family residences and Saint Helen Catholic Church
West	Vacant, undeveloped land

RECs were not observed with the adjoining properties.

7.0 ADDITIONAL SERVICES

Per the agreed scope of services specified in the proposal, additional services (e.g. asbestos sampling, lead-based paint sampling, wetlands evaluation, lead in drinking water testing, radon testing, vapor encroachment screening, etc.) were not conducted.

In conjunction with this ESA report, a Geologic Assessment (GA) (Terracon Project No. 96177607A) and a Cultural Resource Assessment (CR) (Terracon Project No. 96177607B) were conducted and these reports will be issued under separate cover.

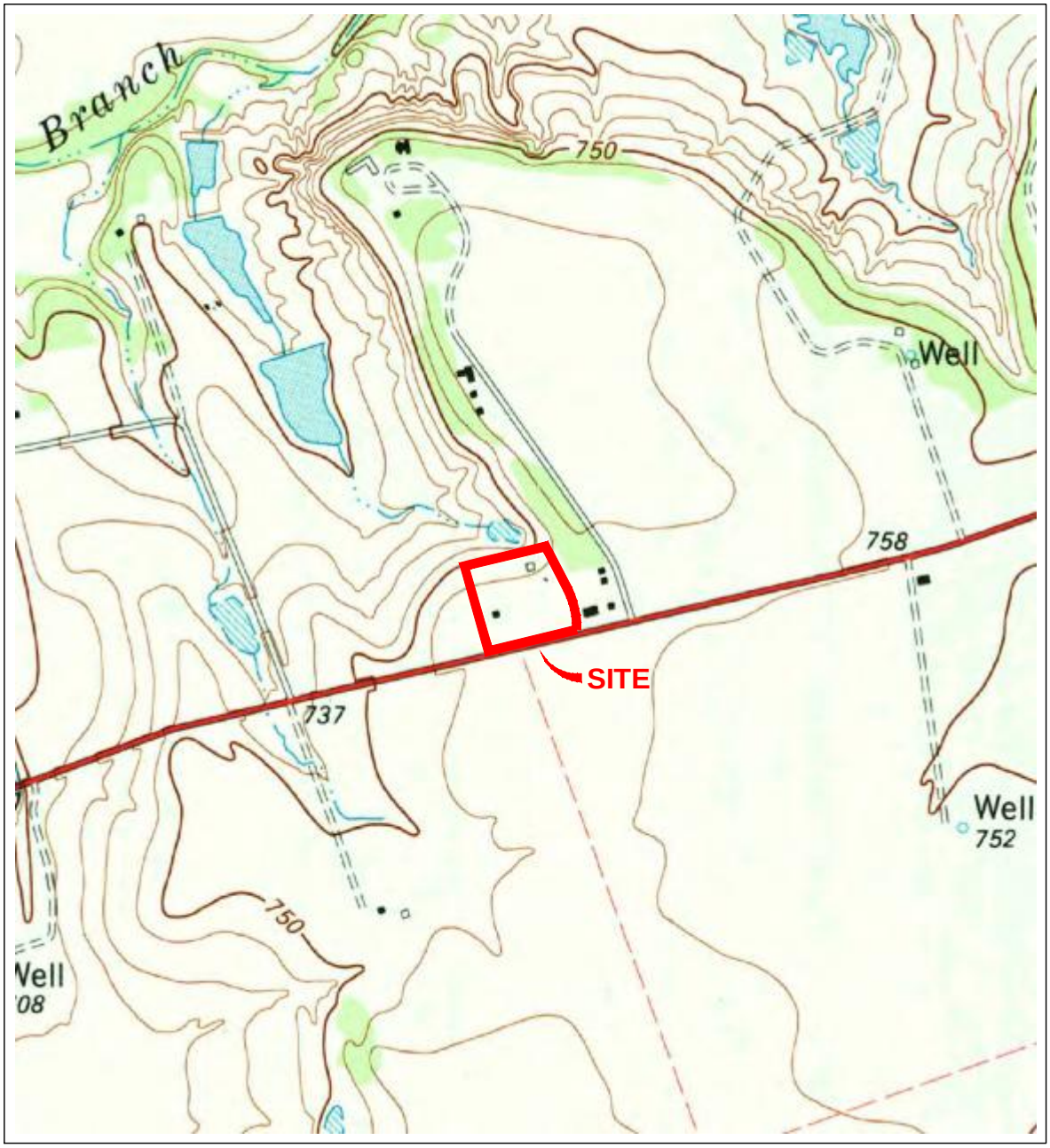
8.0 DECLARATION

I, Rhonda L. Alford, declare that, to the best of my professional knowledge and belief, I meet the definition of Environmental Professional as defined in Section 312.10 of 40 CFR 312; and I have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the site. I have developed and performed the All Appropriate Inquiries in conformance with the standards and practices set forth in 40 CFR Part 312.

Rhonda L. Alford
Authorized Project Reviewer

APPENDIX A
EXHIBIT 1 – TOPOGRAPHIC MAP
EXHIBIT 2 – SITE DIAGRAM

UNITED STATES — DEPARTMENT OF THE INTERIOR — GEOLOGICAL SURVEY



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.5 .25 0 KILOMETERS .5 1

500 0 METERS 500 1000

.5 .25 0 .5

MILES

500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

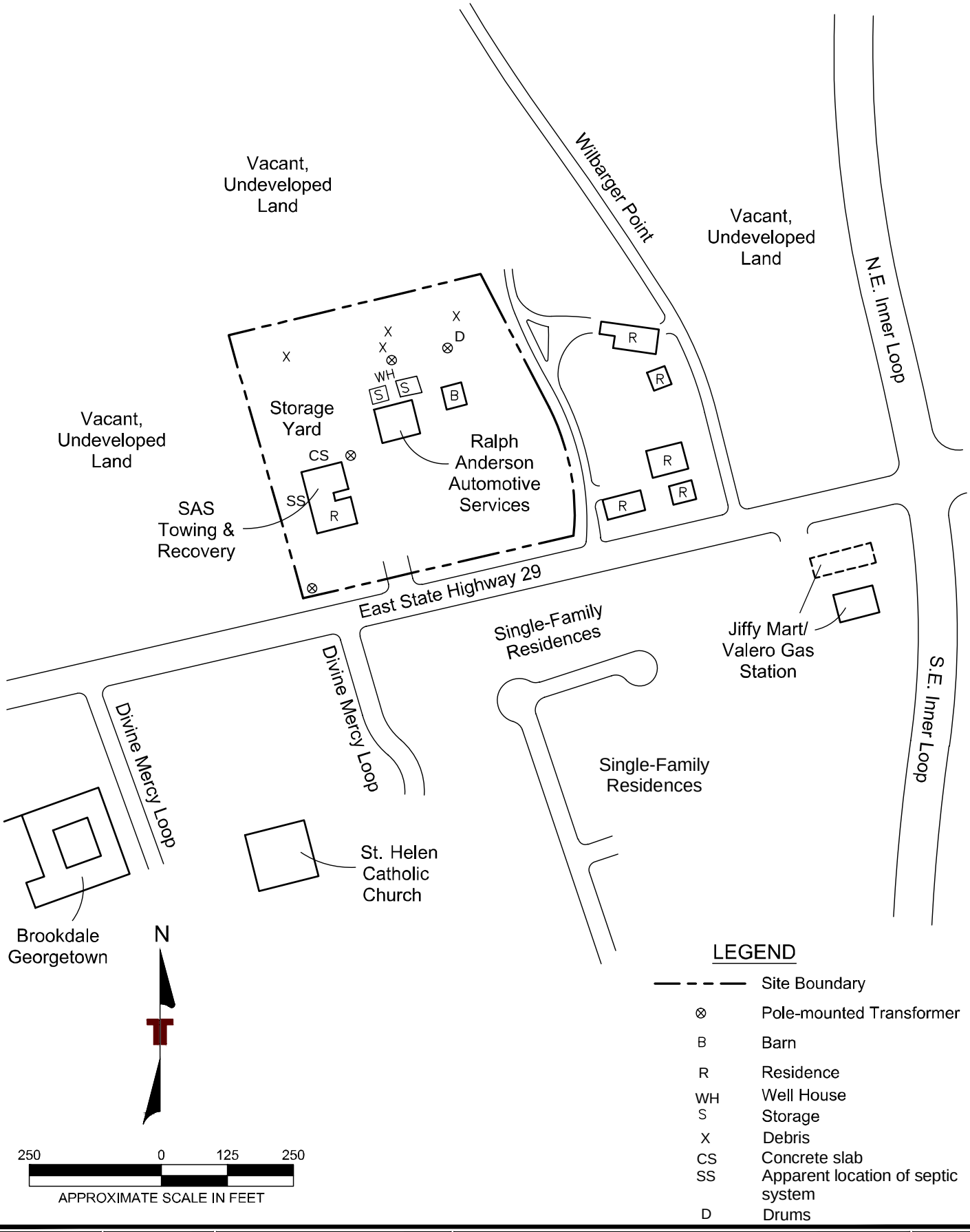
CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

Georgetown, Texas
30097-F6-TF-024
1982
7.5 MINUTE SERIES (TOPOGRAPHIC)

Project Mngr: SRS	Project No. 96177607	Terracon Consulting Engineers and Scientists	TOPOGRAPHIC MAP
Drawn By: ATX Drafting	Scale: AS SHOWN	5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735	Proposed Fire Station #7
Checked By: RLA	File No. 96177607	PH. (512) 442-1122 FAX (512) 442-1181	2703 East Highway 29
Approved By: RLA	Date: Oct 23, 2017		Georgetown, Williamson County, Texas

EXHIBIT 1



Project Mngr: SRS	Project No. 96177607	Terracon Consulting Engineers and Scientists	SITE DIAGRAM
Drawn By: ATX Drafting	Scale: AS SHOWN	5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735	Proposed Fire Station #7
Checked By: RLA	File No. 96177607	PH. (512) 442-1122 FAX (512) 442-1181	2703 East Highway 29
Approved By: RLA	Date: Oct 23, 2017		Georgetown, Williamson County, Texas

EXHIBIT 2

APPENDIX B
SITE PHOTOGRAPHS

Photo 1 General view of the site facing northeast

Photo 2 View of the northern portion of the site facing east

Photo 3 View of debris on the northern portion of the site

Photo 4 View of pole-mounted transformer on the northern portion of the site

Photo 5 View of well house on the northern portion of the site

Photo 6 View inside the well house

Photo 7 View of debris on the northern portion of the site

Photo 8 View of 55-gallon drums on the northern portion of the site

Photo 9 View of hollow-sounding area on the northern portion of the site

Photo 10 View of pole-mounted transformer on the northern portion of the site

Photo 11 View of trailer and debris on the northern portion of the site

Photo 12 View of the eastern portion of the site facing north

Photo 13 View of tires on the eastern portion of the site

Photo 14 View of car parts on the eastern portion of the site

Photo 15 View of the southern portion of the site facing west

Photo 16 View of the western portion of the site and on-site residence facing northeast

Photo 17 View of pole-mounted transformer on the southwestern corner of the site

Photo 18 View of SAS Towing & Recovery office

Photo 19 View of on-site dumpster on the central portion of the site

Photo 20 View of SAS Towing & Recovery storage yard facing north

Photo 21 View of SAS Towing & Recovery storage yard facing northwest

Photo 22 View of chemical totes in SAS Towing & Recovery storage yard

Photo 23 View of gasoline containers near the on-site residence

Photo 24 View of concrete slab behind the SAS Towing & Recovery office

Photo 25 View of barn on the central portion of the site

Photo 26 View of chemical totes in the barn

Photo 27 View of tires in the barn

Photo 28 View of used oil buckets in the barn

Photo 29 View of used oil buckets in the barn

Photo 30 View of automotive service shop on the central portion of the site

Photo 31 View of air compressor outside the automotive service shop

Photo 32 View of empty 55-gallon drum near the automotive services shop

Photo 33 View of SAS Towing & Recovery storage shed

Photo 34 View of large shipping container owned by third party

Photo 35 View inside automotive service shop

Photo 36 View of used antifreeze storage inside the automotive service shop

Photo 37 View of water storage container inside the automotive service shop

Photo 38 View inside the automotive service shop

Photo 39 View inside the automotive service shop

Photo 40 View of hydraulic lifts inside the automotive service shop

Photo 41 View of air compressor inside the automotive service shop

Photo 42 View of car parts on the central portion of the site near the automotive service shop

Photo 43 View inside the automotive service shop

Photo 44 View inside the automotive service shop

Photo 45 View of parts cleaner and used oil filter containers in automotive service shop

Photo 46 View of water storage containers in the automotive service shop

Photo 47 View of compressed gas cylinders in the automotive service shop

Photo 48 View inside the automotive service shop

Photo 49 View of east adjoining property (residences)

Photo 50 View of south adjoining property (East Highway 29 and residences)

APPENDIX C
HISTORICAL DOCUMENTATION AND USER QUESTIONNAIRE

Client/User Required Questionnaire

Terracon

Person Completing Questionnaire	Name: ERIC JOHNSON Phone: 512-819-3145 Company: CITY OF GEORGETOWN Email: ERIC.JOHNSON@GEORGETOWN.ORG
Site Name	FIRE STATION #7
Site Address	2705 E. HWY 29 GEORGETOWN TX 78614
Point of Contact for Access	Name: 48 HOURS NOTICE Phone: (512) ~~844~~ 844-9687 Company: Email:
Access Restrictions or Special Site Requirements?	___No ✓Yes (If yes, please explain) CONTACT VIA PHONE 512-844-9687 48 HOURS PRIOR TO ENTRY
Confidentiality Requirements?	___No ✓Yes (If yes, please explain) DUE DILLIGENCE FOR LAND ACQUISITION
Current Site Owner	Name: JAMES E ROBINSON FAMILY TRUST Phone: 512-844-9687 Company: Email:
Current Site Operator	Name: Phone: Company: Email:
Reasons for ESA (e.g., financing, acquisition, lease, etc.)	ACQUISITION
Anticipated Future Site Use	FIRE STATION
Relevant Documents?	Please provide Terracon copies of prior Phase I or II ESAs, Asbestos Surveys, Environmental Permits or Audit documents, Underground Storage Tank documents, Geotechnical Investigations, Site Surveys, Diagrams or Maps, or other relevant reports or documents. NONE AVAILABLE

ASTM User Questionnaire

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Relief and Brownfields Revitalization Act of 2001 (the "Brownfields Amendments"), the user must respond to the following questions. Failure to provide this information to the environmental professional may result in significant data gaps, which may limit our ability to identify recognized environmental conditions resulting in a determination that "all appropriate inquiry" is not complete. This form represents a type of interview and as such, the user has an obligation to answer all questions in good faith, to the extent of their actual knowledge.

1) Did a search of recorded land title records (or judicial records where appropriate) identify any environmental liens filed or recorded against the property under federal, tribal, state, or local law (40 CFR 312.25)?
✓No ___Yes ___Title search not completed (If yes, explain below and send Terracon a copy of the Chain of Title report.)

2) Did a search of recorded land title records (or judicial records where appropriate) identify any activity and use limitations (AULs), such as engineering controls, land use restrictions, or institutional controls that are in place at the property and/or have been filed or recorded against the property under federal, tribal, state, or local law (40 CFR 312.26)?
✓No ___Yes ___Title search not completed (If yes, explain below and send Terracon a copy of the Chain of Title report.)

3) Do you have any specialized knowledge or experience related to the site or nearby properties? For example, are you involved in the same line of business as the current or former occupants of the site or an adjoining property so that you would have specialized knowledge of the chemicals and processes used by this type of business (40 CFR 312-28)?
✓No ___Yes (If yes, explain below)

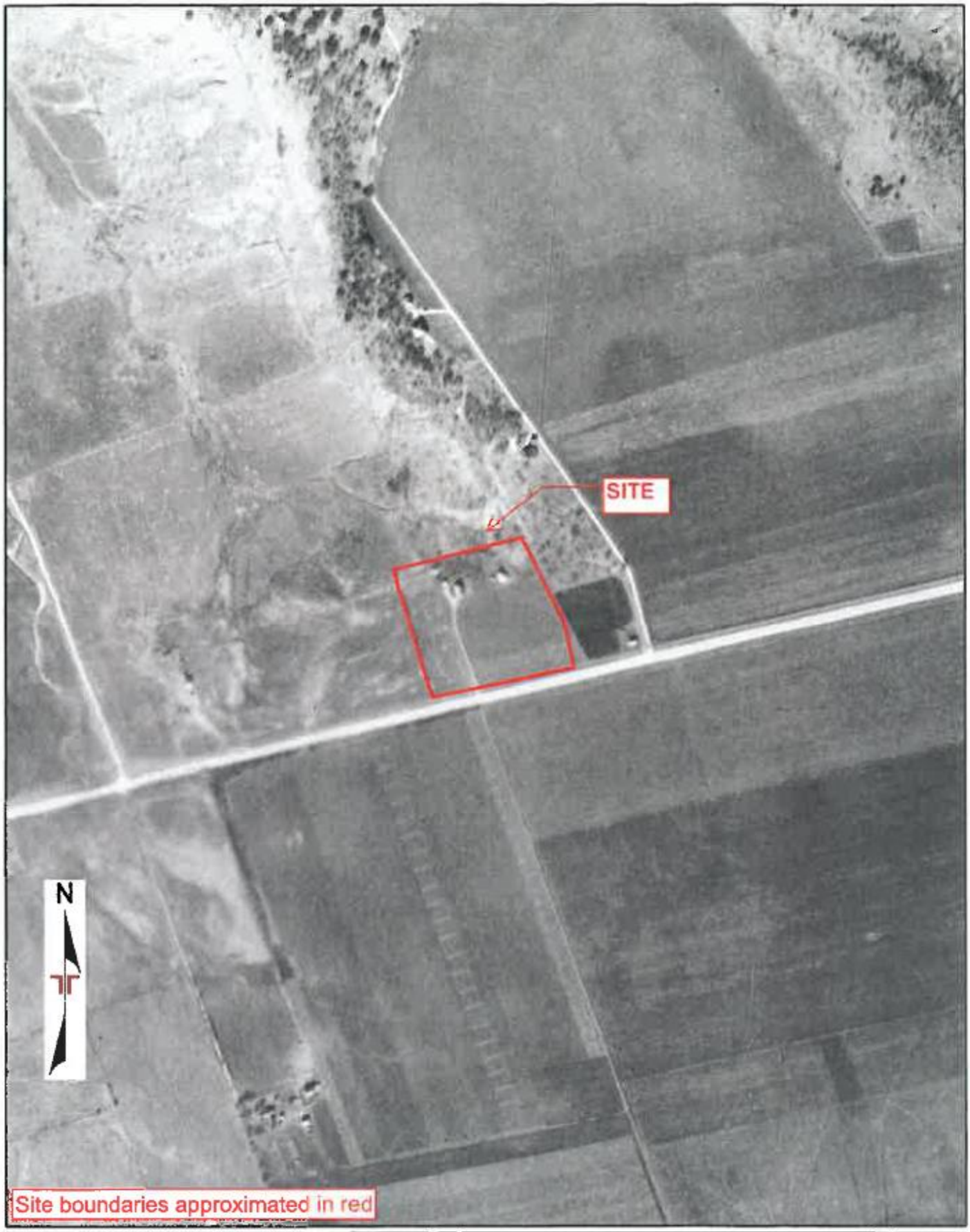
4) Do you have actual knowledge of a lower purchase price because contamination is known or believed to be present at the site (40 CFR 312.29)?
✓No ___Yes ___Not applicable (If yes, explain below)

5) Are you aware of commonly known or reasonably ascertainable information about the site that would help the environmental professional to identify conditions indicative of releases or threatened releases (40 CFR 312.30)?
✓No ___Yes (If yes, explain below)

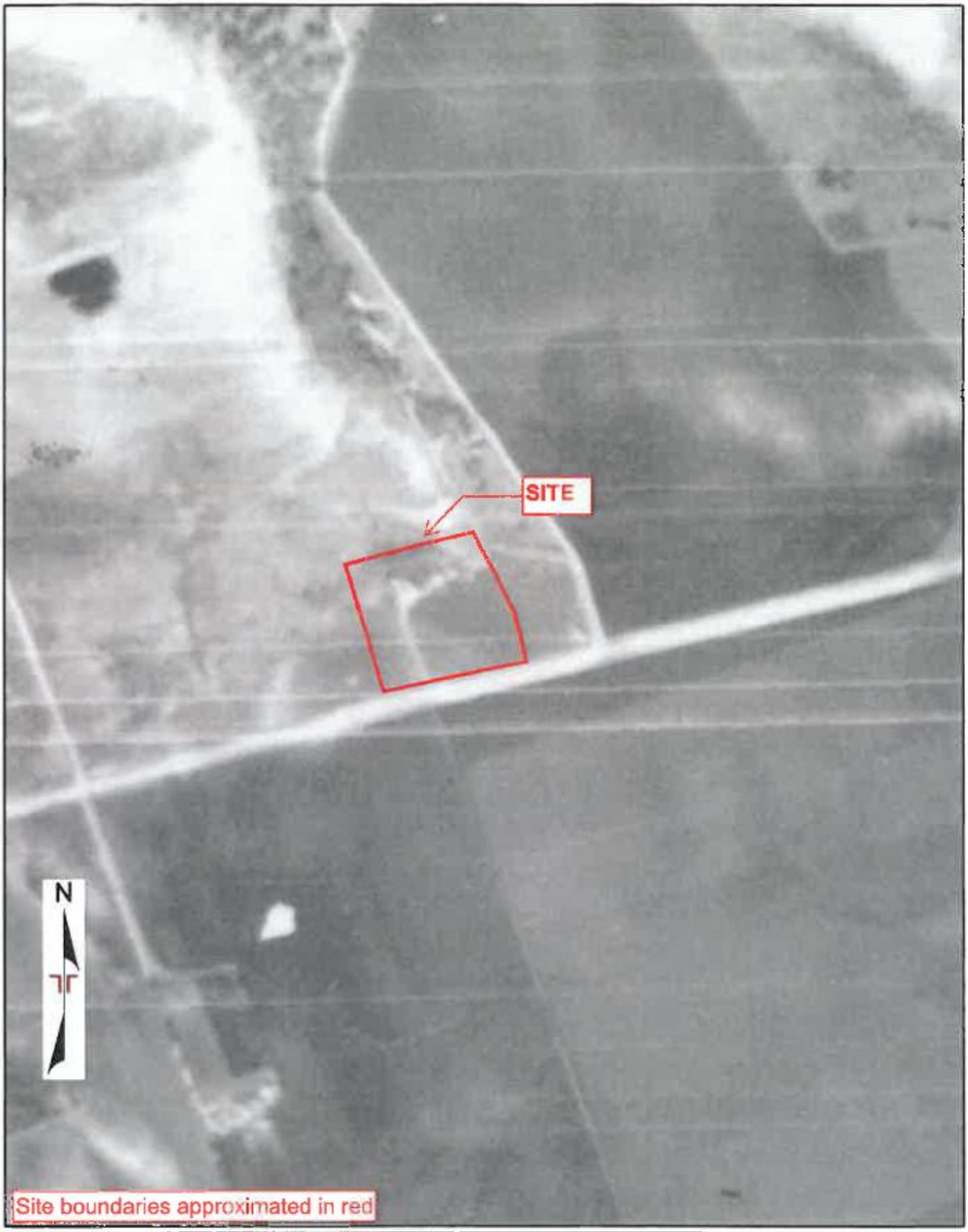
6) Based on your knowledge and experience related to the site, are there any obvious indicators that point to the presence or likely presence of contamination at the site (40 CFR 312.31)?
✓No ___Yes (If yes, explain below)

Comments or explanations:

Please return this form with the signed authorization to proceed. Proposal No. P96177607



Project Manager: SRS	Project No: 96177607	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
Drawn by: GeoSearch	Scale: 1" = 500'			
Checked by: RLA	File Name: ASCS			
Approved by: RLA	Date: 12/28/1941			



Project Manager: SRS	Project No: 96177607	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
Drawn by: GeoSearch	Scale: 1" = 500'			
Checked by: RLA	File Name: AMS			
Approved by: RLA	Date: 01/25/1953			

Site boundaries approximated in red

Project Manager: SRS	Project No: 96177607	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
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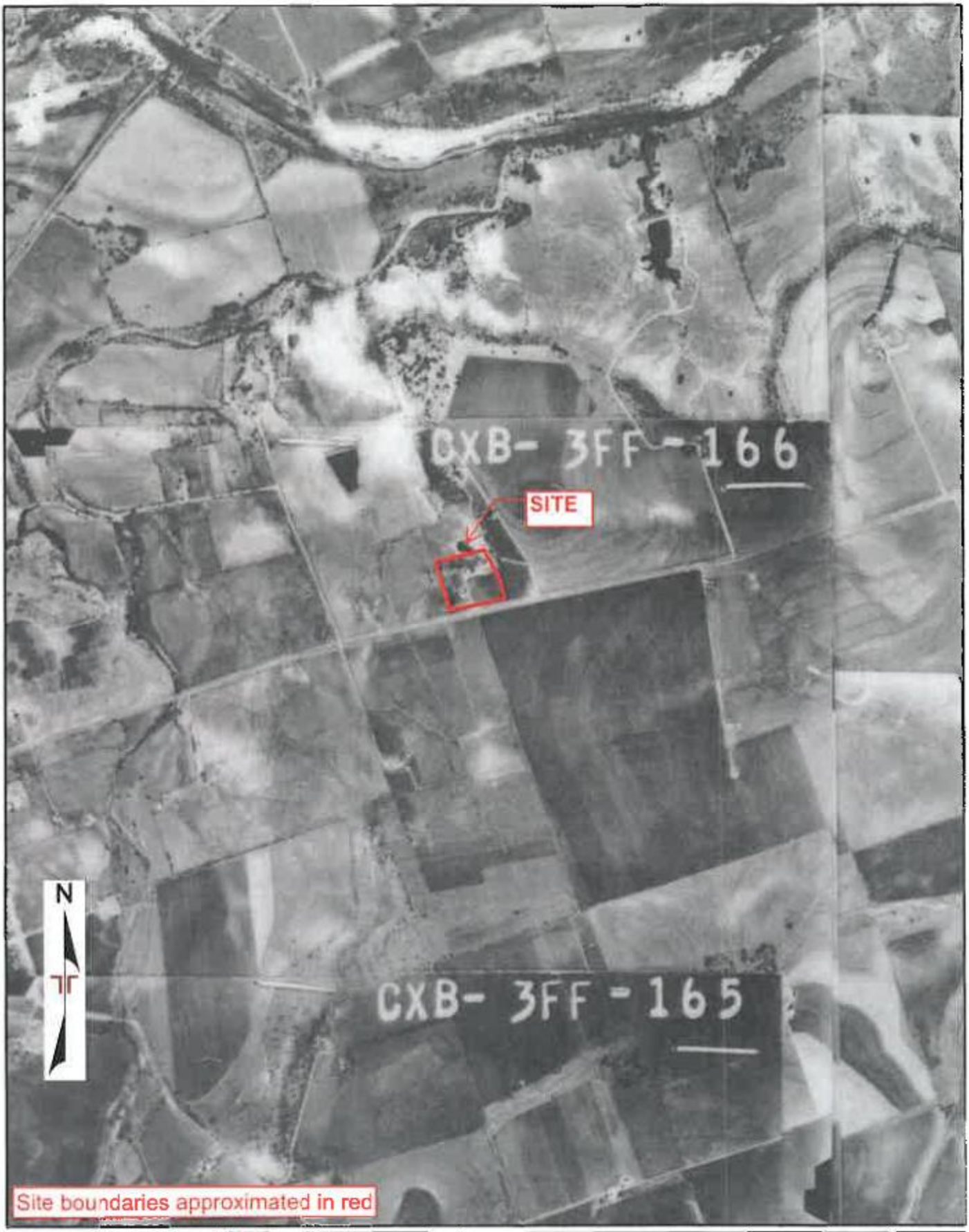
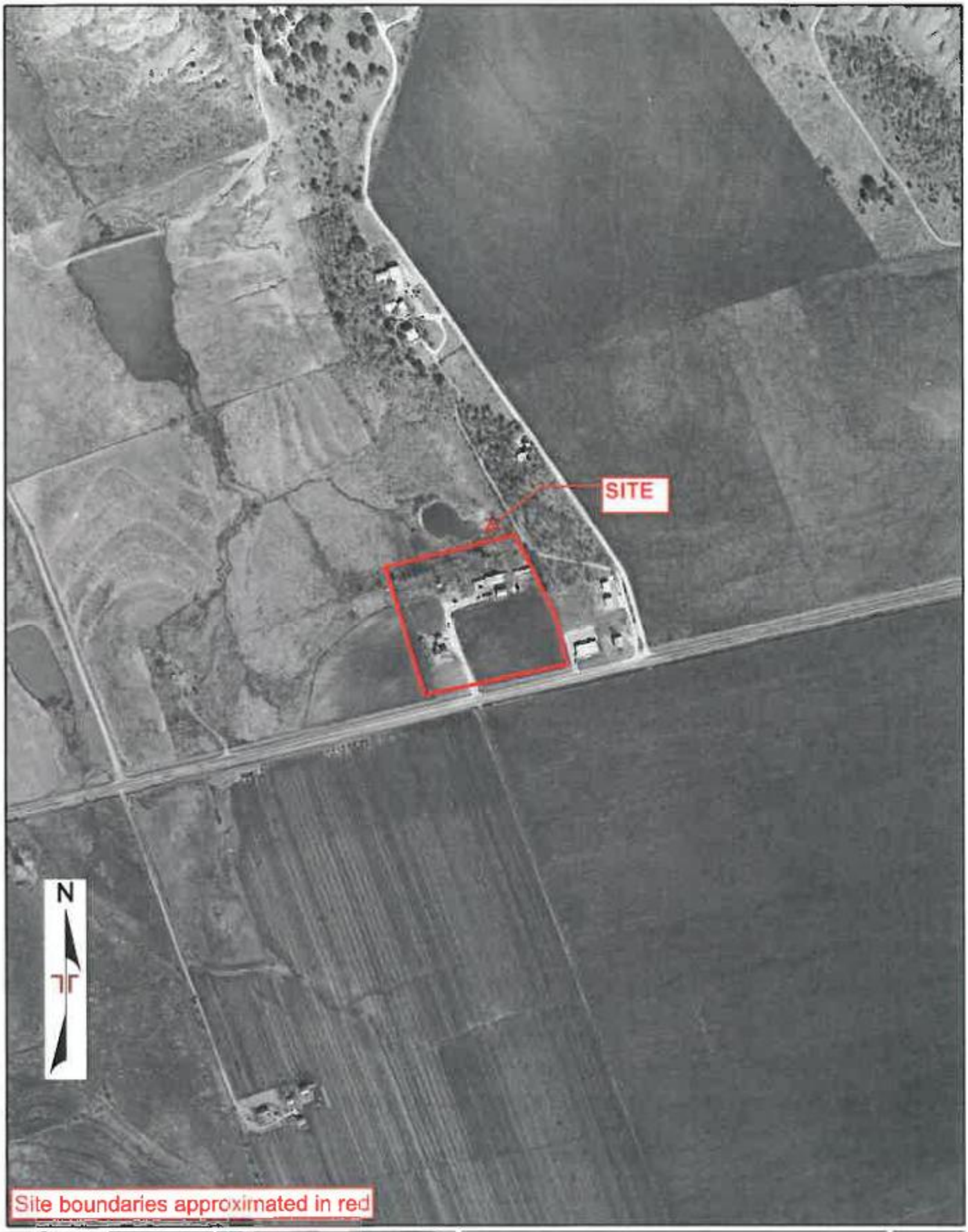
Approved by: RLA	Date: 01/27/1958			



Project Manager: SRS	Project No: 96177607	Terracon	AERIAL PHOTOGRAPH
Drawn by: GeoSearch	Scale: 1" = 1320'	5307 Industrial Blvd, Ste 160	Proposed Fire Station #7
Checked by: RLA	File Name: ASCS	Austin, Texas 78735	2703 East Highway 29
Approved by: RLA	Date: 10/22/1964		Georgetown, Texas 78626

Appendix C



Project Manager: SRS	Project No: 96177607	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
Drawn by: GeoSearch	Scale: 1" = 500'			
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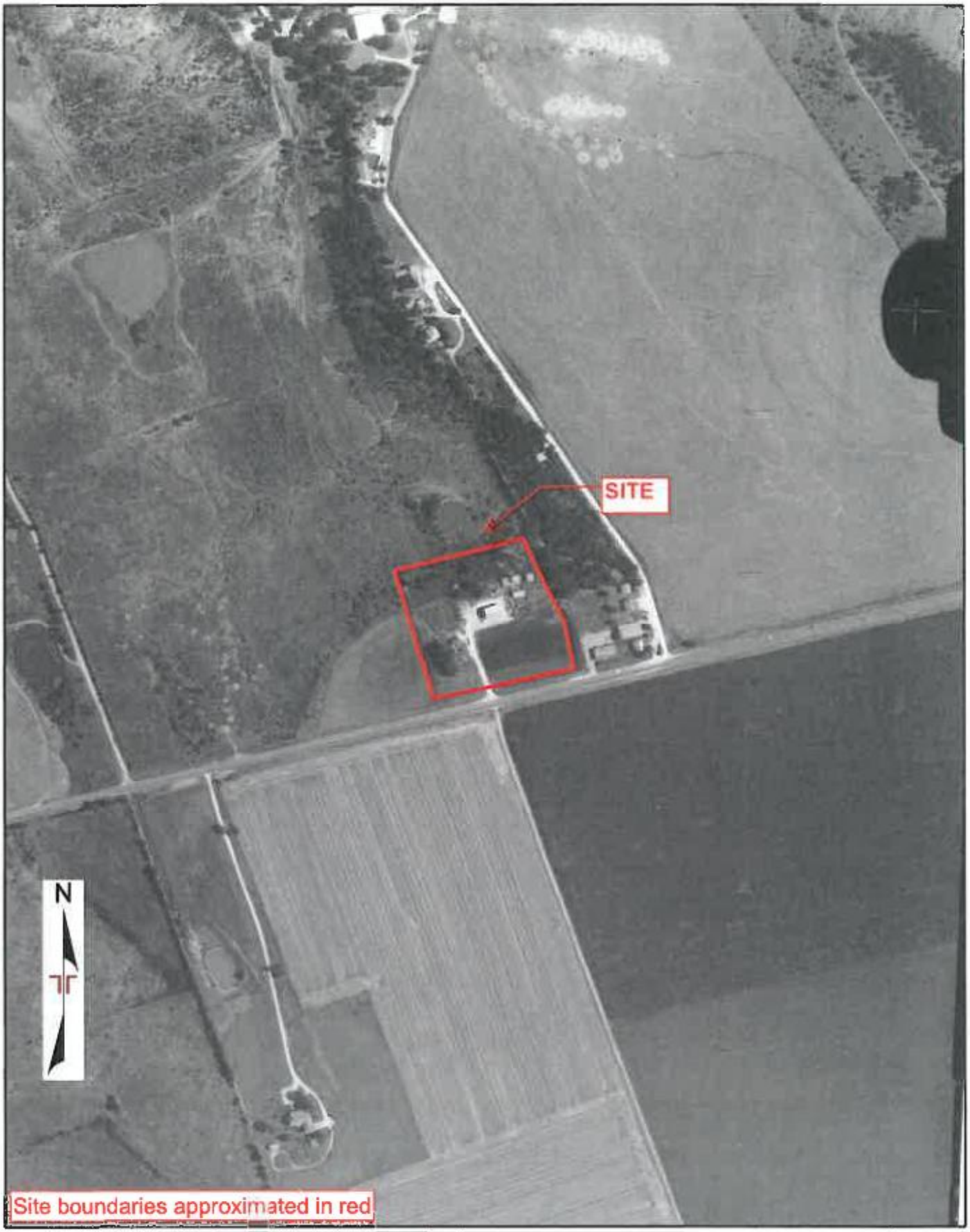
Approved by: RLA	Date: 01/30/1974			



Project Manager: SRS	Project No: 98177607	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
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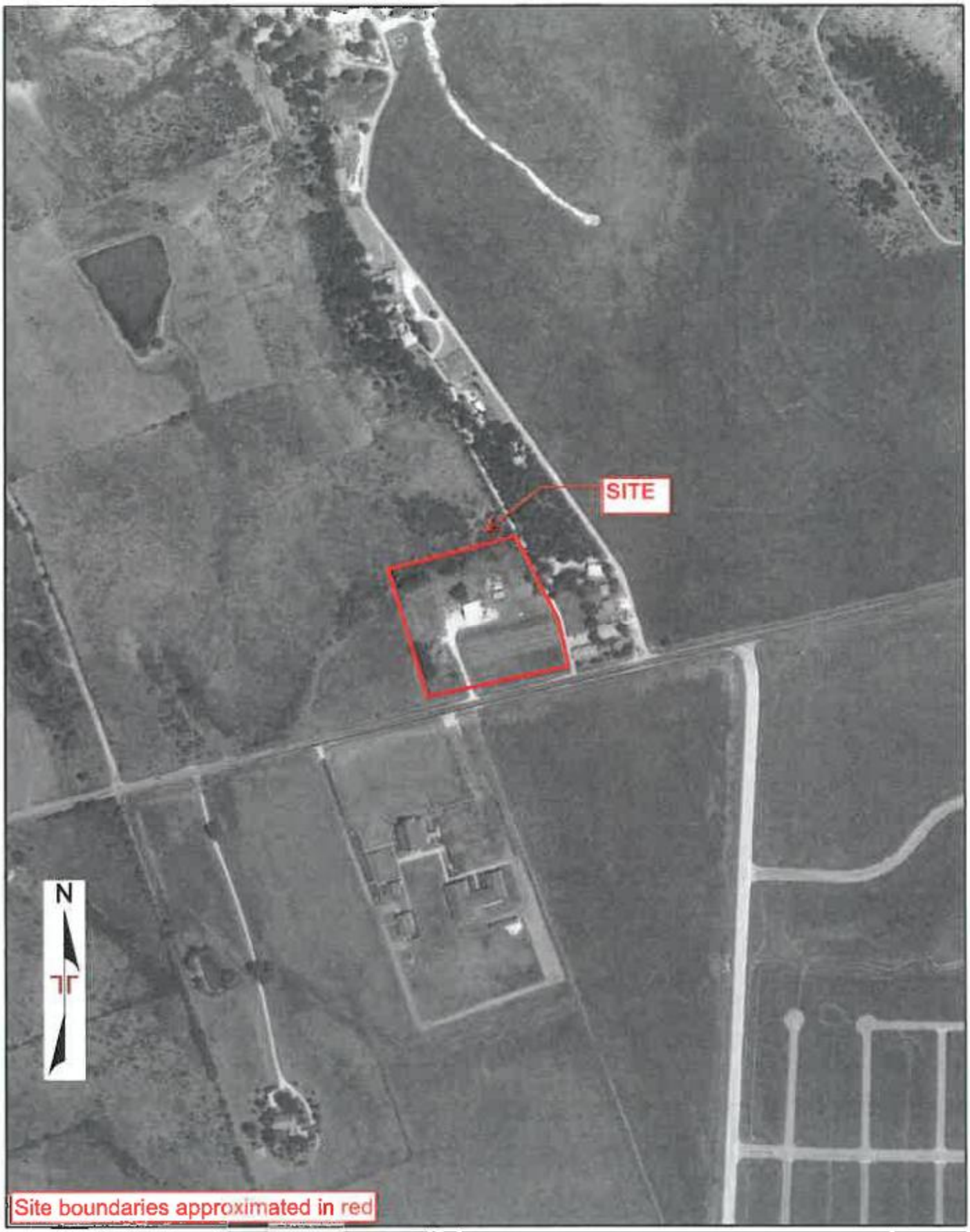
Approved by: RLA	Date: 05/19/1981			



Project Manager: SRS	Project No: 96177607	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH	Appendix
Drawn by: GeoSearch	Scale: 1" = 500'		Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	C
Checked by: RLA	File Name: TXDOT			
Approved by: RLA	Date: 07/22/1968			

Project Manager: SRS	Project No: 96177607
Drawn by: GeoSearch	Scale: 1" = 500'
Checked by: RLA	File Name: USGS
Approved by: RLA	Date: 02/02/1995

Terracon
6307 Industrial Blvd, Ste 160
Austin, Texas 78735

AERIAL PHOTOGRAPH

Proposed Fire Station #7
2703 East Highway 29
Georgetown, Texas 78626

Appendix
C

Project Manager: SRS	Project No: 96177807	Terracon 5307 Industrial Blvd, Ste 180 Austin, Texas 78735	AERIAL PHOTOGRAPH Proposed Fire Station #7 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
Drawn by: GeoSearch	Scale: 1" = 500'			
Checked by: RLA	File Name: USDA			
Approved by: RLA	Date: 2004			

Project Manager: SRS	Project No: 96177807	Terracon 5307 Industrial Blvd, Ste 160 Austin, Texas 78735	AERIAL PHOTOGRAPH **Proposed Fire Station #7** 2703 East Highway 29 Georgetown, Texas 78626	Appendix C
Drawn by: GeoSearch	Scale: 1" = 500'			
Checked by: RLA	File Name: USDA			
Approved by: RLA	Date: 2014			

GeoSearch FIM

Date: 10/13/17

GS Job Number: 94422

Company Name: Terracon Consultants-Austin

Project Number: 96177607

Site Information: Proposed Fire Station #7
E University Ave, Georgetown, Williamson, Texas, 78626

The collections of fire insurance maps listed below were reviewed according to the site information supplied by client. Based on the information provided, no coverage is available.

Library of Congress
University Publications of America
Other Libraries (universities, state, local, etc.).

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APPENDIX D
ENVIRONMENTAL DATABASE INFORMATION

GeoSearch
On time. On target. In touch.™

Radius Report

Satellite view

Target Property:

Proposed Fire Station #7
E University Ave
Georgetown, Williamson County, Texas 78626

Prepared For:

Terracon Consultants-Austin

Order #: 94422
Job #: 206816
Project #: 96177607
Date: 10/13/2017

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Unlocated Sites Summary 24

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Unlocatable Report . . . . . See Attachment

Zip Report . . . . . See Attachment

Disclaimer

This report was designed by GeoSearch to meet or exceed the records search requirements of the All Appropriate Inquiries Rule (40 CFR §312.26) and the current version of the ASTM International E1527, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process or, if applicable, the custom requirements requested by the entity that ordered this report. The records and databases of records used to compile this report were collected from various federal,state and local governmental entities. It is the goal of GeoSearch to meet or exceed the 40 CFR §312.26 and E1527 requirements for updating records by using the best available technology. GeoSearch contacts the appropriate governmental entities on a recurring basis. Depending on the frequency with which a record source or database of records is updated by the governmental entity, the data used to prepare this report may be updated monthly, quarterly, semi-annually, or annually.

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Target Property Summary

Target Property Information

Proposed Fire Station #7
E University Ave
Georgetown, Texas 78626

Coordinates
Area centroid (-97.646170, 30.6389195)
762 feet above sea level

USGS Quadrangle
Georgetown, TX

Geographic Coverage Information

County/Parish: Williamson (TX)
ZipCode(s):
Georgetown TX: 78626

Radon
* Target property is located in Radon Zone 3.
Zone 3 areas have a predicted average indoor radon screening level less than 2 pCi/L (picocuries per liter).

Database Summary

FEDERAL LISTING

Standard Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
EMERGENCY RESPONSE NOTIFICATION SYSTEM	ERNSTX	0	0	TP/AP
FEDERAL ENGINEERING INSTITUTIONAL CONTROL SITES	EC	0	0	TP/AP
LAND USE CONTROL INFORMATION SYSTEM	LUCIS	0	0	TP/AP
RCRA SITES WITH CONTROLS	RCRASC	0	0	TP/AP
RESOURCE CONSERVATION & RECOVERY ACT - NON-GENERATOR	RCRANGR06	0	0	0.1250
FEMA OWNED STORAGE TANKS	FEMAUST	0	0	0.2500
RESOURCE CONSERVATION & RECOVERY ACT - GENERATOR	RCRAGR06	0	0	0.2500
BROWNFIELDS MANAGEMENT SYSTEM	BF	0	0	0.5000
DELISTED NATIONAL PRIORITIES LIST	DNPL	0	0	0.5000
NO LONGER REGULATED RCRA NON-CORRACTS TSD FACILITIES	NLRRCRAT	0	0	0.5000
RESOURCE CONSERVATION & RECOVERY ACT - NON-CORRACTS TREATMENT, STORAGE & DISPOSAL FACILITIES	RCRAT	0	0	0.5000
SUPERFUND ENTERPRISE MANAGEMENT SYSTEM	SEMS	0	0	0.5000
SUPERFUND ENTERPRISE MANAGEMENT SYSTEM ARCHIVED SITE INVENTORY	SEMSARCH	0	0	0.5000
NATIONAL PRIORITIES LIST	NPL	0	0	1.0000
NO LONGER REGULATED RCRA CORRECTIVE ACTION FACILITIES	NLRRCRAC	0	0	1.0000
PROPOSED NATIONAL PRIORITIES LIST	PNPL	0	0	1.0000
RESOURCE CONSERVATION & RECOVERY ACT - CORRECTIVE ACTION FACILITIES	RCRAC	0	0	1.0000
RESOURCE CONSERVATION & RECOVERY ACT - SUBJECT TO CORRECTIVE ACTION FACILITIES	RCRASUBC	0	0	1.0000

SUB-TOTAL		0	0	

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
AEROMETRIC INFORMATION RETRIEVAL SYSTEM / AIR FACILITY SUBSYSTEM	AIRSAFS	0	0	TP/AP
BIENNIAL REPORTING SYSTEM	BRS	0	0	TP/AP
CERCLIS LIENS	SFLIENS	0	0	TP/AP
CLANDESTINE DRUG LABORATORY LOCATIONS	CDL	0	0	TP/AP
EPA DOCKET DATA	DOCKETS	0	0	TP/AP
ENFORCEMENT AND COMPLIANCE HISTORY INFORMATION	ECHOR06	0	0	TP/AP

Database Summary

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
FACILITY REGISTRY SYSTEM	FRSTX	0	0	TP/AP
HAZARDOUS MATERIALS INCIDENT REPORTING SYSTEM	HMIRSR06	0	0	TP/AP
INTEGRATED COMPLIANCE INFORMATION SYSTEM (FORMERLY DOCKETS)	ICIS	0	0	TP/AP
INTEGRATED COMPLIANCE INFORMATION SYSTEM NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM	ICISNPDES	0	0	TP/AP
MATERIAL LICENSING TRACKING SYSTEM	MLTS	0	0	TP/AP
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM	NPDESR06	0	0	TP/AP
PCB ACTIVITY DATABASE SYSTEM	PADS	0	0	TP/AP
PERMIT COMPLIANCE SYSTEM	PCSR06	0	0	TP/AP
SEMS LIEN ON PROPERTY	SEMSLIENS	0	0	TP/AP
SECTION SEVEN TRACKING SYSTEM	SSTS	0	0	TP/AP
TOXIC SUBSTANCE CONTROL ACT INVENTORY	TSCA	0	0	TP/AP
TOXICS RELEASE INVENTORY	TRI	0	0	TP/AP
ALTERNATIVE FUELING STATIONS	ALTFUELS	0	0	0.2500
HISTORICAL GAS STATIONS	HISTPST	0	0	0.2500
INTEGRATED COMPLIANCE INFORMATION SYSTEM DRYCLEANERS	ICISCLEANERS	0	0	0.2500
MINE SAFETY AND HEALTH ADMINISTRATION MASTER INDEX FILE	MSHA	0	0	0.2500
MINERAL RESOURCE DATA SYSTEM	MRDS	0	0	0.2500
OPEN DUMP INVENTORY	ODI	0	0	0.5000
SURFACE MINING CONTROL AND RECLAMATION ACT SITES	SMCRA	0	0	0.5000
URANIUM MILL TAILINGS RADIATION CONTROL ACT SITES	USUMTRCA	0	0	0.5000
DEPARTMENT OF DEFENSE SITES	DOD	0	0	1.0000
FORMER MILITARY NIKE MISSILE SITES	NMS	0	0	1.0000
FORMERLY USED DEFENSE SITES	FUDS	0	0	1.0000
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM	FUSRAP	0	0	1.0000
RECORD OF DECISION SYSTEM	RODS	0	0	1.0000

SUB-TOTAL		0	0	

Database Summary

STATE (TX) LISTING

Standard Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
STATE INSTITUTIONAL/ENGINEERING CONTROL SITES	SIEC01	0	0	TP/AP
DRY CLEANER REGISTRATION DATABASE	DCR	0	0	0.2500
PETROLEUM STORAGE TANKS	PST	1	0	0.2500
BROWNFIELDS SITE ASSESSMENTS	BSA	0	0	0.5000
CLOSED & ABANDONED LANDFILL INVENTORY	CALF	0	0	0.5000
LEAKING PETROLEUM STORAGE TANKS	LPST	0	0	0.5000
MUNICIPAL SOLID WASTE LANDFILL SITES	MSWLF	0	0	0.5000
RADIOACTIVE WASTE SITES	RWS	0	0	0.5000
RAILROAD COMMISSION VCP AND BROWNFIELD SITES	RRCVCP	0	0	0.5000
VOLUNTARY CLEANUP PROGRAM SITES	VCP	0	0	0.5000
INDUSTRIAL AND HAZARDOUS WASTE CORRECTIVE ACTION SITES	IHWCA	0	0	1.0000
STATE SUPERFUND SITES	SF	0	0	1.0000
SUB-TOTAL		1	0	

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
GROUNDWATER CONTAMINATION CASES	GWCC	0	0	TP/AP
HISTORIC GROUNDWATER CONTAMINATION CASES	HISTGWCC	0	0	TP/AP
MUNICIPAL SETTING DESIGNATIONS	MSD	0	0	TP/AP
NOTICE OF VIOLATIONS	NOV	0	0	TP/AP
SPILLS LISTING	SPILLS	0	0	TP/AP
TCEQ LIENS	LIENS	0	0	TP/AP
TIER I I CHEMICAL REPORTING PROGRAM FACILITIES	TIERII	0	0	TP/AP
INDUSTRIAL AND HAZARDOUS WASTE SITES	IHW	0	0	0.2500
PERMITTED INDUSTRIAL HAZARDOUS WASTE SITES	PIHW	0	0	0.2500
AFFECTED PROPERTY ASSESSMENT REPORTS	APAR	0	0	0.5000
DRY CLEANER REMEDIATION PROGRAM SITES	DCRPS	0	0	0.5000
INNOCENT OWNER / OPERATOR DATABASE	IOP	0	0	0.5000
RECYCLING FACILITIES	WMRF	0	0	0.5000
SALT CAVERNS FOR PETROLEUM STORAGE	STCV	0	0	0.5000
SUB-TOTAL		0	0	

Database Summary

Database Summary

LOCAL LISTING

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
EDWARDS AQUIFER PERMITS	EAP	0	0	TP/AP
SUB-TOTAL		0	0	

TRIBAL LISTING

Standard Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
UNDERGROUND STORAGE TANKS ON TRIBAL LANDS	USTR06	0	0	0.2500
LEAKING UNDERGROUND STORAGE TANKS ON TRIBAL LANDS	LUSTR06	0	0	0.5000
OPEN DUMP INVENTORY ON TRIBAL LANDS	ODINDIAN	0	0	0.5000
SUB-TOTAL		0	0	

Additional Environmental Records

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
INDIAN RESERVATIONS	INDIANRES	0	0	1.0000
SUB-TOTAL		0	0	
TOTAL		1	0	

Database Radius Summary

FEDERAL LISTING

*Standard environmental records are displayed in **bold**.*

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
AIRSAFS	0.0200	0	NS	NS	NS	NS	NS	0
BRS	0.0200	0	NS	NS	NS	NS	NS	0
CDL	0.0200	0	NS	NS	NS	NS	NS	0
DOCKETS	0.0200	0	NS	NS	NS	NS	NS	0
EC	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
ECHOR06	0.0200	0	NS	NS	NS	NS	NS	0
ERNSTX	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
FRSTX	0.0200	0	NS	NS	NS	NS	NS	0
HMIRSR06	0.0200	0	NS	NS	NS	NS	NS	0
ICIS	0.0200	0	NS	NS	NS	NS	NS	0
ICISNPDES	0.0200	0	NS	NS	NS	NS	NS	0
LUCIS	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
MLTS	0.0200	0	NS	NS	NS	NS	NS	0
NPDESR06	0.0200	0	NS	NS	NS	NS	NS	0
PADS	0.0200	0	NS	NS	NS	NS	NS	0
PCSR06	0.0200	0	NS	NS	NS	NS	NS	0
RCRASC	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
SEMSLIENS	0.0200	0	NS	NS	NS	NS	NS	0
SFLIENS	0.0200	0	NS	NS	NS	NS	NS	0
SSTS	0.0200	0	NS	NS	NS	NS	NS	0
TRI	0.0200	0	NS	NS	NS	NS	NS	0
TSCA	0.0200	0	NS	NS	NS	NS	NS	0
RCRANGR06	**0.1250**	**0**	**0**	**NS**	**NS**	**NS**	**NS**	**0**
ALTFUELS	0.2500	0	0	0	NS	NS	NS	0
FEMAUST	**0.2500**	**0**	**0**	**0**	**NS**	**NS**	**NS**	**0**
HISTPST	0.2500	0	0	0	NS	NS	NS	0
ICISCLEANERS	0.2500	0	0	0	NS	NS	NS	0
MRDS	0.2500	0	0	0	NS	NS	NS	0
MSHA	0.2500	0	0	0	NS	NS	NS	0
RCRAGR06	**0.2500**	**0**	**0**	**0**	**NS**	**NS**	**NS**	**0**
BF	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
DNPL	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
NLRRCRAT	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
ODI	0.5000	0	0	0	0	NS	NS	0
RCRAT	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**

Database Radius Summary

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
SEMS	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
SEMSARCH	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
SMCRA	0.5000	0	0	0	0	NS	NS	0
USUMTRCA	0.5000	0	0	0	0	NS	NS	0
DOD	1.0000	0	0	0	0	0	NS	0
FUDS	1.0000	0	0	0	0	0	NS	0
FUSRAP	1.0000	0	0	0	0	0	NS	0
NLRRCRAC	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
NMS	1.0000	0	0	0	0	0	NS	0
NPL	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
PNPL	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
RCRAC	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
RCRASUBC	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
RODS	1.0000	0	0	0	0	0	NS	0
SUB-TOTAL		0	0	0	0	0	0	0

Database Radius Summary

STATE (TX) LISTING

*Standard environmental records are displayed in **bold**.*

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
GWCC	0.0200	0	NS	NS	NS	NS	NS	0
HISTGWCC	0.0200	0	NS	NS	NS	NS	NS	0
LIENS	0.0200	0	NS	NS	NS	NS	NS	0
MSD	0.0200	0	NS	NS	NS	NS	NS	0
NOV	0.0200	0	NS	NS	NS	NS	NS	0
SIEC01	**0.0200**	**0**	**NS**	**NS**	**NS**	**NS**	**NS**	**0**
SPILLS	0.0200	0	NS	NS	NS	NS	NS	0
TIERII	0.0200	0	NS	NS	NS	NS	NS	0
DCR	**0.2500**	**0**	**0**	**0**	**NS**	**NS**	**NS**	**0**
IHW	0.2500	0	0	0	NS	NS	NS	0
PIHW	0.2500	0	0	0	NS	NS	NS	0
PST	**0.2500**	**0**	**1**	**0**	**NS**	**NS**	**NS**	**1**
APAR	0.5000	0	0	0	0	NS	NS	0
BSA	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
CALF	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
DCRPS	0.5000	0	0	0	0	NS	NS	0
IOP	0.5000	0	0	0	0	NS	NS	0
LPST	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
MSWLF	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
RRCVCP	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
RWS	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
STCV	0.5000	0	0	0	0	NS	NS	0
VCP	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
WMRF	0.5000	0	0	0	0	NS	NS	0
IHWCA	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**
SF	**1.0000**	**0**	**0**	**0**	**0**	**0**	**NS**	**0**

SUB-TOTAL		0	1	0	0	0	0	1

Database Radius Summary

LOCAL LISTING

*Standard environmental records are displayed in **bold**.*

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
EAP	0.0200	0	NS	NS	NS	NS	NS	0
SUB-TOTAL		0	0	0	0	0	0	0

Database Radius Summary

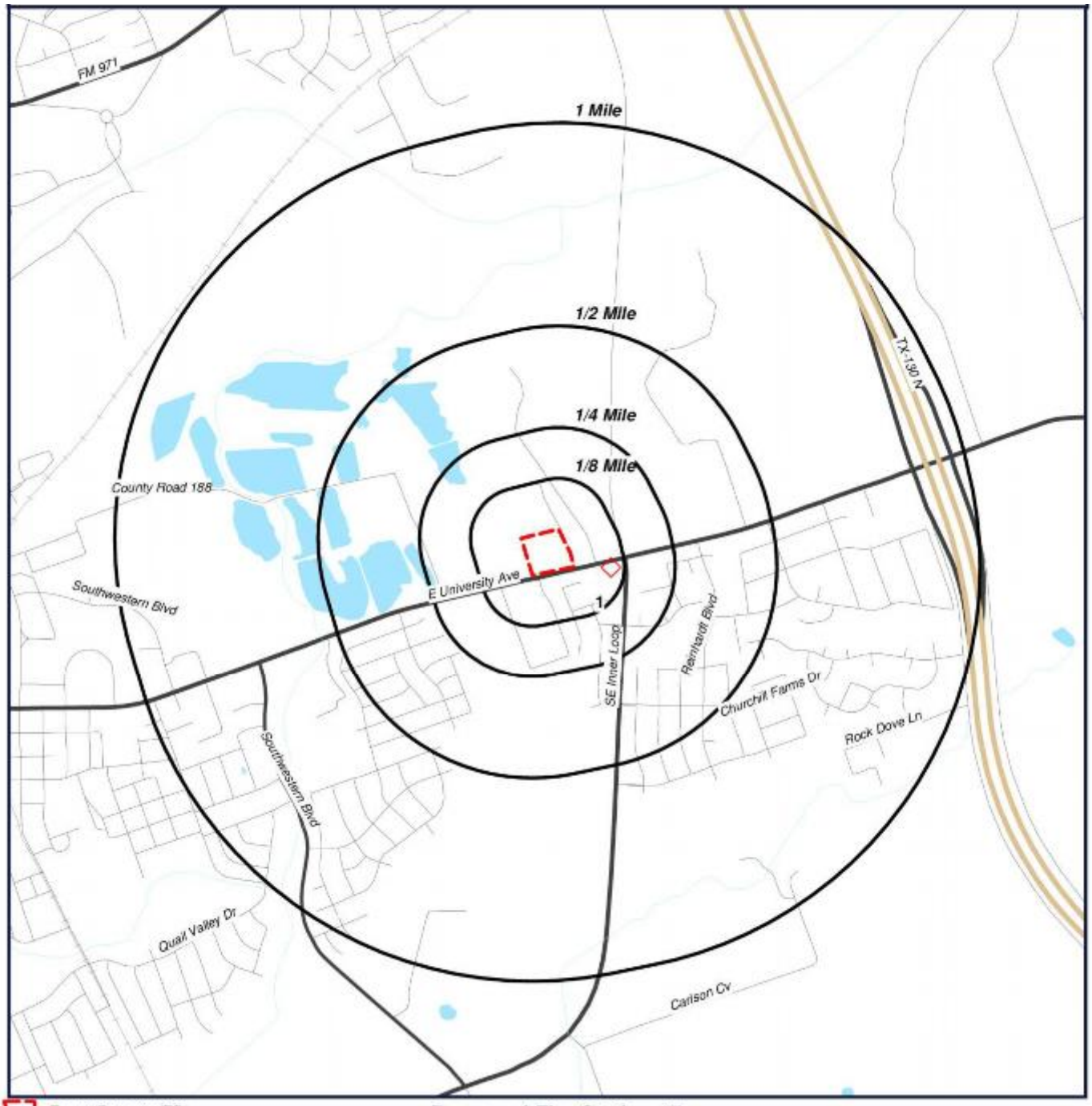
TRIBAL LISTING

*Standard environmental records are displayed in **bold**.*

Acronym	Search Radius (miles)	TP/AP (0 - 0.02)	1/8 Mile (> TP/AP)	1/4 Mile (> 1/8)	1/2 Mile (> 1/4)	1 Mile (> 1/2)	> 1 Mile	Total
USTR06	**0.2500**	**0**	**0**	**0**	**NS**	**NS**	**NS**	**0**
LUSTR06	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
ODINDIAN	**0.5000**	**0**	**0**	**0**	**0**	**NS**	**NS**	**0**
INDIANRES	1.0000	0	0	0	0	0	NS	0
SUB-TOTAL		0	0	0	0	0	0	0
TOTAL		0	1	0	0	0	0	1

NOTES:
NS = NOT SEARCHED
TP/AP = TARGET PROPERTY/ADJACENT PROPERTY

Radius Map 1



Target Property (TP)
PST

Proposed Fire Station #7
E University Ave
Georgetown, Texas
78626

N
W E
S

0' 1000' 2000' 3000'
SCALE: 1" = 2000'

[Click here to access Satellite view]

Radius Map 2

Target Property (TP)
PST

Proposed Fire Station #7
E University Ave
Georgetown, Texas
78626

N
W E
S

0' 500' 1000' 1500'
SCALE: 1" = 1000'

[Click here to access Satellite view]

Ortho Map

Target Property (TP)
PST

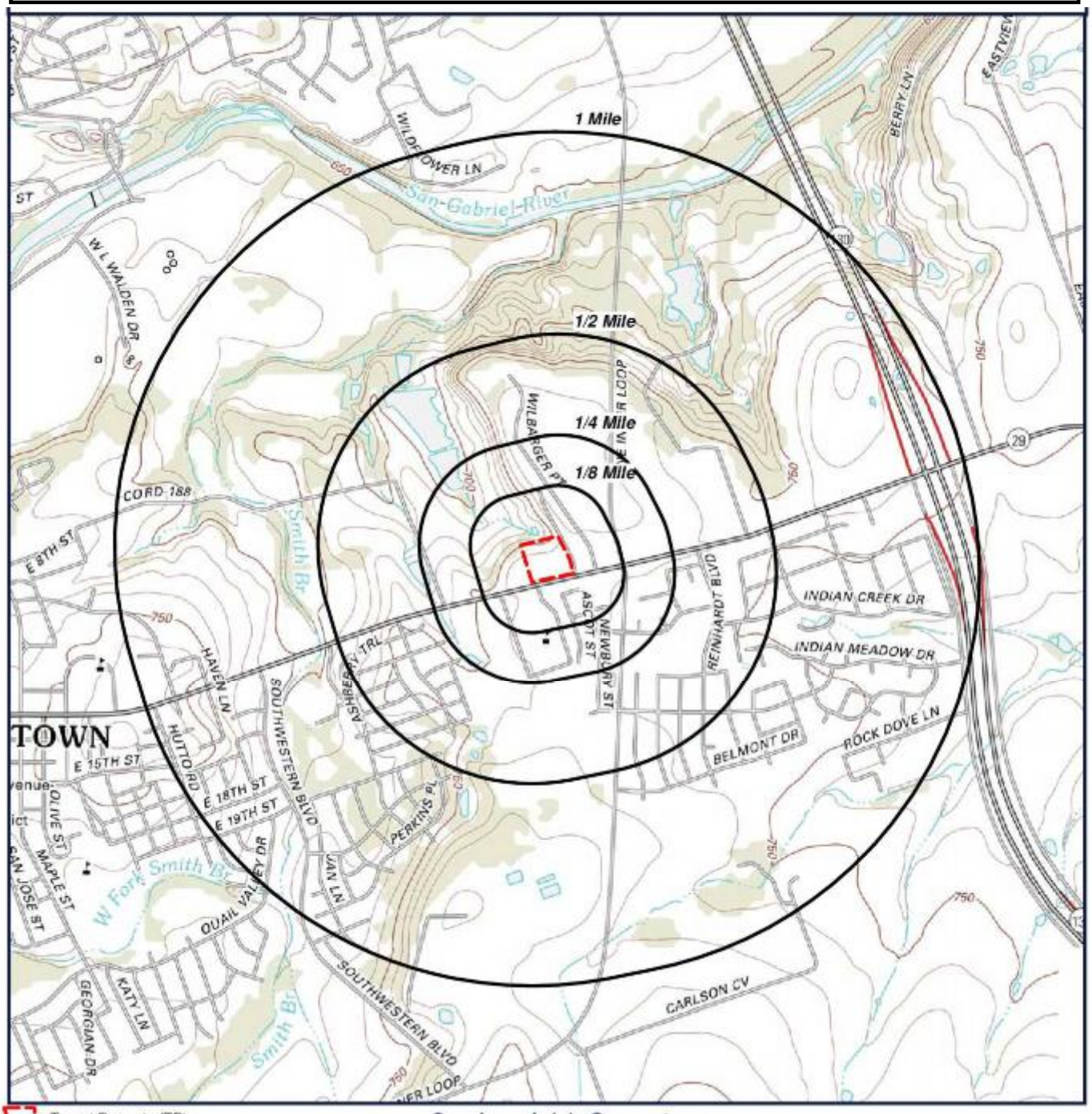
Quadrangle(s): Georgetown
Proposed Fire Station #7
E University Ave
Georgetown, Texas
78626

N
W E
S

0' 500' 1000' 1500'
SCALE: 1" = 1000'

[Click here to access Satellite view]

Topographic Map



Target Property (TP)

Quadrangle(s): Georgetown
Source: USGS, 01/22/2013
Proposed Fire Station #7
E University Ave
Georgetown, Texas
78626

N
W E
S

0' 1000' 2000' 3000'
SCALE: 1" = 2000'

[Click here to access Satellite view]

Located Sites Summary

*NOTE: Standard environmental records are displayed in **bold**.*

Map ID#	Database Name	Site ID#	Relative Elevation	Distance From Site	Site Name	Address	PAGE #
1	***PST***	***69511***	***Equal (762 ft.)***	***0.1 mi. E (528 ft.)***	***JIFFY MART 6***	***2850 E UNIVERSITY AVE, GEORGETOWN, TX 78626***	*19*

Elevation Summary

Elevations are collected from the USGS 3D Elevation Program 1/3 arc-second (approximately 10 meters) layer hosted at the NGTOC. .

Target Property Elevation: 762 ft.

*NOTE: Standard environmental records are displayed in **bold**.*

EQUAL/HIGHER ELEVATION

Map ID#	Database Name	Elevation	Site Name	Address	Page #
1	PST	762 ft.	JIFFY MART 6	2850 E UNIVERSITY AVE, GEORGETOWN, TX 78626	19

LOWER ELEVATION

No Records Found

MAP ID# 1

Distance from Property: 0.1 mi. (528 ft.) E
Elevation: 762 ft. (Equal to TP)

FACILITY INFORMATION

ID#: **69511**
NAME: **JIFFY MART 6**
ADDRESS: **2850 E UNIVERSITY AVE**
GEORGETOWN, TX 78626
COUNTY: **WILLIAMSON**
REGION: **11**
TYPE: **RETAIL**
BEGIN DATE: **12/23/1996**
STATUS: **ACTIVE**
EXEMPT STATUS: **NO**
RECORDS OFF-SITE: **NO**
NUMBER OF ACTIVE UNDERGROUND TANKS: **2**
NUMBER OF ACTIVE ABOVEGROUND TANKS: **0**

CONTACT INFORMATION

NAME: **MUBARAK BHANDARI**
TITLE: **MGR**
ORGANIZATION: **JIFFY MART 6**
MAIL ADDRESS: **MAILING ADDRESS NOT REPORTED**
CITY NOT REPORTED
PHONE: **(512) 8697262 0**

APPLICATION INFORMATION:

RECEIVED DATE ON EARLIEST REGISTRATION FORM: **01/17/2017**
SIGNATURE DATE ON EARLIEST REGISTRATION FORM: **01/16/2017**
SIGNATURE NAME & TITLE: **SOMI MAREDIA, REP**
ENFORCEMENT ACTION DATE: **NOT REPORTED**

OWNER

OWNER NUMBER: **CN600744940**
NAME: **CHURCHES HILL GROCERY INC**
CONTACT ADDRESS: **2850 E UNIVERSITY AVE**
GEORGETOWN TX 78626
TYPE: **CORPORATION/COMPANY**
BEGIN DATE: **02/28/2005**
CONTACT ROLE: **OWNOPRCON**
CONTACT NAME: **MUBARAK BHANDARI**
CONTACT TITLE: **MGR**
ORGANIZATION: **CHURCHES HILL GROCERY INC**
PHONE: **(512) 8697262 0**
FAX: **NOT REPORTED**
EMAIL: **NOT REPORTED**

OPERATOR

OPERATOR NUMBER: **CN600744940**
NAME: **CHURCHES HILL GROCERY INC**
CONTACT ADDRESS: **2850 E UNIVERSITY AVE**
GEORGETOWN TX 78626
TYPE: **CORPORATION/COMPANY**
BEGIN DATE: **02/28/2005**
CONTACT ROLE: **OWNOPRCON**
CONTACT NAME: **MUBARAK BHANDARI**
CONTACT TITLE: **MGR**

ORGANIZATION: **CHURCHES HILL GROCERY INC**
PHONE: **(512) 8697262 0**
FAX: **NOT REPORTED**
EMAIL: **NOT REPORTED**

SELF-CERTIFICATION

SELF-CERTIFICATION ID: **281391**
SIGNATURE DATE: **01/16/2017**
SIGNATURE NAME & TITLE: **SOMI MAREDIA, REP**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **264073**
SIGNATURE DATE: **01/19/2016**
SIGNATURE NAME & TITLE: **SOMI MAREDIA, REP**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **247846**
SIGNATURE DATE: **01/20/2015**
SIGNATURE NAME & TITLE: **ASMITA MANSIYA, REP**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **232864**
SIGNATURE DATE: **02/26/2014**
SIGNATURE NAME & TITLE: **ASMITA MANSIYA, REP**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173690**
SIGNATURE DATE: **02/06/2013**
SIGNATURE NAME & TITLE: **ANIL MOMIN, REPRESENTATIVE**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173689**
SIGNATURE DATE: **02/27/2012**
SIGNATURE NAME & TITLE: **ANIL MOMIN, REP**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173688**
SIGNATURE DATE: **12/29/2010**
SIGNATURE NAME & TITLE: **RIAZ ALI, MGR**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173687**
SIGNATURE DATE: **01/29/2010**
SIGNATURE NAME & TITLE: **MUBARAK BHANDARI, MGR**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173686**
SIGNATURE DATE: **01/20/2009**

SIGNATURE NAME & TITLE: **MUBARAK BHANDARI, MGR**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173685**
SIGNATURE DATE: **01/28/2008**
SIGNATURE NAME & TITLE: **MUBARAK BHANDARI, MGR**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173684**
SIGNATURE DATE: **01/25/2007**
SIGNATURE NAME & TITLE: **JIMMY BADARPURA, MGR**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173683**
SIGNATURE DATE: **04/10/2006**
SIGNATURE NAME & TITLE: **JIMMY BADARPURA, MGR**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173682**
SIGNATURE DATE: **02/28/2005**
SIGNATURE NAME & TITLE: **SHAUKAT MAHESAME, OFFICER**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173681**
SIGNATURE DATE: **03/29/2004**
SIGNATURE NAME & TITLE: **SHAUKAT MAHESANIA, OFFICER**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173680**
SIGNATURE DATE: **03/10/2003**
SIGNATURE NAME & TITLE: **SHAUKAT MAHESANIA, OFFICER**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173679**
SIGNATURE DATE: **06/13/2002**
SIGNATURE NAME & TITLE: **SHAUKAT MAHESANIA, OFFICER**
FILING STATUS: **INITIAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173678**
SIGNATURE DATE: **02/19/2002**
SIGNATURE NAME & TITLE: **SHAUKAT MAHESANIA, OFFICER**
FILING STATUS: **RENEWAL**
REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173677**
SIGNATURE DATE: **08/17/2001**
SIGNATURE NAME & TITLE: **SHAUKAT MAHESANIA, OFFICER**
FILING STATUS: **INITIAL**

REGISTRATION FLAG: **YES**
SELF-CERTIFICATION ID: **173676**
SIGNATURE DATE: **04/26/2001**
SIGNATURE NAME & TITLE: **BILL CHAPMAN, PRES**
FILING STATUS: **INITIAL**
REGISTRATION FLAG: **YES**

CONSTRUCTION NOTIFICATION

NOTIFICATION CONSTRUCTION ID: **19657**
APPLICATION RECEIVED DATE: **03/03/2011**
SCHEDULE CONSTRUCTION DATE: **03/02/2011**
GENERAL DESCRIPTION OF PROPOSED CONSTRUCTION:
ON LINE TO DETERMINE WHICH ONE TO START WITH. BREAK OUT SQUARE BY PUMP 5&6 LINE WAS NO GOOD. REPAIR WITH AO SMITH DOUBLE WALL SECTION THAT WAS BAD.

UNDERGROUND STORAGE TANK

TANK ID: **1**
NUMBER OF COMPARTMENTS: **1**
INSTALLATION DATE: **12/23/1996**
REGISTRATION DATE: **04/18/1997**
TANK CAPACITY (GAL): **12000**
EMPTY TANK: **NOT EMPTY**
STATUS: **IN USE**
STATUS BEGIN DATE: **12/23/1996**
INTERNAL PROTECTION DATE: **NOT REPORTED**
REGULATORY STATUS: **FULLY REGULATED**
TANK DESIGN SINGLE WALL: **NO**
TANK DESIGN DOUBLE WALL: **YES**
PIPE DESIGN SINGLE WALL: **NO**
PIPE DESIGN DOUBLE WALL: **YES**

TANK DETAILS

MATERIAL:
COMPOSITE
CORROSION PROTECTION:
COMPOSITE TANK (STEEL W/FRP EXTERNAL LAMINATE)
EXTERNAL CONTAINMENT:
NOT REPORTED
TANK COMPLIANCE FLAG
CORROSION PROTECTION COMPLIANCE FLAG: **YES**
CORROSION PROTECTION VARIANCE: **NO VARIANCE**

COMPARTMENT DETAILS

UST COMPARTMENT ID: **173910**
TANK ID: **1**
COMPARTMENT LETTER: **A**
SUBSTANCES: **GASOLINE**
OTHER SUBSTANCES: **NOT REPORTED**
CAPACITY (GAL): **12000**
COMPARTMENT RELEASE DETECTION: **AUTOMATIC TANK GAUGE TEST & INVENTORY CONTROL,INTERSTITIAL MONITORING WITHIN SECONDARY WALL/JACKET**
SPILL CONTAINMENT AND OVERFILL PREVENTION: **TIGHT-FILL FITTING CONTAINER/BUCKET/SUMP,FACTORY - BUILT SPILL CONTAINER/BUCKET/SUMP,DELIVERY SHUT-OFF VALVE**

PIPING SYSTEMS

MATERIAL: **FRP**
CORROSION PROTECTION: **FRP TANK OR PIPING (NONCORRODIBLE)**
EXTERNAL CONTAINMENT: **NOT REPORTED**
CONNECTORS & VALVES:

NOT REPORTED

PIPEING RELEASE DETECTION:

ANNUAL PIPING TIGHTNESS TEST / ANNUAL ELECTRONIC MONITORING (@ 0.1 GPH),AUTO. LINE LEAK DETECTOR (3.0 GPH FOR PRESSURE PIPING)

PIPE COMPLIANCE FLAG

CORROSION PROTECTION COMPLIANCE FLAG: **YES**

CORROSION PROTECTION VARIANCE: **NO VARIANCE**

TANK ID: **2**

NUMBER OF COMPARTMENTS: **2**

INSTALLATION DATE: **12/23/1996**

REGISTRATION DATE: **04/18/1997**

TANK CAPACITY (GAL): **12000**

EMPTY TANK: **NOT EMPTY**

STATUS: **IN USE**

STATUS BEGIN DATE: **12/23/1996**

INTERNAL PROTECTION DATE: **NOT REPORTED**

REGULATORY STATUS: **FULLY REGULATED**

TANK DESIGN SINGLE WALL: **NO**

TANK DESIGN DOUBLE WALL: **YES**

PIPE DESIGN SINGLE WALL: **NO**

PIPE DESIGN DOUBLE WALL: **YES**

TANK DETAILS

MATERIAL:

COMPOSITE

CORROSION PROTECTION:

COMPOSITE TANK (STEEL W/FRP EXTERNAL LAMINATE)

EXTERNAL CONTAINMENT:

NOT REPORTED

TANK COMPLIANCE FLAG

CORROSION PROTECTION COMPLIANCE FLAG: **YES**

CORROSION PROTECTION VARIANCE: **NO VARIANCE**

COMPARTMENT DETAILS

UST COMPARTMENT ID: **173911**

TANK ID: **2**

COMPARTMENT LETTER: **A**

SUBSTANCES: **GASOLINE**

OTHER SUBSTANCES: **NOT REPORTED**

CAPACITY (GAL): **6000**

COMPARTMENT RELEASE DETECTION: **AUTOMATIC TANK GAUGE TEST & INVENTORY CONTROL,INTERSTITIAL MONITORING WITHIN SECONDARY WALL/JACKET**

SPILL CONTAINMENT AND OVERFILL PREVENTION: **TIGHT-FILL FITTING CONTAINER/BUCKET/SUMP,FACTORY - BUILT SPILL CONTAINER/BUCKET/SUMP,DELIVERY SHUT-OFF VALVE**

PIPING SYSTEMS

MATERIAL: **FRP**

CORROSION PROTECTION: **FRP TANK OR PIPING (NONCORRODIBLE)**

EXTERNAL CONTAINMENT: **NOT REPORTED**

CONNECTORS & VALVES:

NOT REPORTED

PIPEING RELEASE DETECTION:

ANNUAL PIPING TIGHTNESS TEST / ANNUAL ELECTRONIC MONITORING (@ 0.1 GPH),AUTO. LINE LEAK DETECTOR (3.0 GPH FOR PRESSURE PIPING)

PIPE COMPLIANCE FLAG

CORROSION PROTECTION COMPLIANCE FLAG: **YES**

CORROSION PROTECTION VARIANCE: **NO VARIANCE**

TANK ID: **2**
NUMBER OF COMPARTMENTS: **2**
INSTALLATION DATE: **12/23/1996**
REGISTRATION DATE: **04/18/1997**
TANK CAPACITY (GAL): **12000**
EMPTY TANK: **NOT EMPTY**
STATUS: **IN USE**
STATUS BEGIN DATE: **12/23/1996**
INTERNAL PROTECTION DATE: **NOT REPORTED**
REGULATORY STATUS: **FULLY REGULATED**
TANK DESIGN SINGLE WALL: **NO**
TANK DESIGN DOUBLE WALL: **YES**
PIPE DESIGN SINGLE WALL: **NO**
PIPE DESIGN DOUBLE WALL: **YES**

TANK DETAILS

MATERIAL:
COMPOSITE
CORROSION PROTECTION:
COMPOSITE TANK (STEEL W/FRP EXTERNAL LAMINATE)
EXTERNAL CONTAINMENT:
NOT REPORTED
TANK COMPLIANCE FLAG
CORROSION PROTECTION COMPLIANCE FLAG: **YES**
CORROSION PROTECTION VARIANCE: **NO VARIANCE**

COMPARTMENT DETAILS

UST COMPARTMENT ID: **173912**
TANK ID: **2**
COMPARTMENT LETTER: **B**
SUBSTANCES: **DIESEL**
OTHER SUBSTANCES: **NOT REPORTED**
CAPACITY (GAL): **6000**
COMPARTMENT RELEASE DETECTION: **AUTOMATIC TANK GAUGE TEST & INVENTORY CONTROL,INTERSTITIAL MONITORING WITHIN SECONDARY WALL/JACKET**
SPILL CONTAINMENT AND OVERFILL PREVENTION: **TIGHT-FILL FITTING CONTAINER/BUCKET/SUMP,FACTORY - BUILT SPILL CONTAINER/BUCKET/SUMP,DELIVERY SHUT-OFF VALVE**

PIPING SYSTEMS

MATERIAL: **FRP**
CORROSION PROTECTION: **FRP TANK OR PIPING (NONCORRODIBLE)**
EXTERNAL CONTAINMENT: **NOT REPORTED**
CONNECTORS & VALVES:
NOT REPORTED
PIPEING RELEASE DETECTION:
ANNUAL PIPING TIGHTNESS TEST / ANNUAL ELECTRONIC MONITORING (@ 0.1 GPH),AUTO. LINE LEAK DETECTOR (3.0 GPH FOR PRESSURE PIPING)
PIPE COMPLIANCE FLAG
CORROSION PROTECTION COMPLIANCE FLAG: **YES**
CORROSION PROTECTION VARIANCE: **NO VARIANCE**

ABOVEGROUND STORAGE TANK INFORMATION

NO ABOVEGROUND STORAGE TANK DATA REPORTED FOR THIS FACILITY

Back to Report Summary

Unlocated Sites Summary

This list contains sites that could not be mapped due to limited or incomplete address information.

No Records Found

AIRSAFS Aerometric Information Retrieval System / Air Facility Subsystem

VERSION DATE: 10/20/14

The United States Environmental Protection Agency (EPA) modified the Aerometric Information Retrieval System (AIRS) to a database that exclusively tracks the compliance of stationary sources of air pollution with EPA regulations: the Air Facility Subsystem (AFS). Since this change in 2001, the management of the AIRS/AFS database was assigned to EPA's Office of Enforcement and Compliance Assurance.

BRS Biennial Reporting System

VERSION DATE: 12/31/11

The United States Environmental Protection Agency (EPA), in cooperation with the States, biennially collects information regarding the generation, management, and final disposition of hazardous wastes regulated under the Resource Conservation and Recovery Act of 1976 (RCRA), as amended. The Biennial Report captures detailed data on the generation of hazardous waste from large quantity generators and data on waste management practices from treatment, storage and disposal facilities. Currently, the EPA states that data collected between 1991 and 1997 was originally a part of the defunct Biennial Reporting System and is now incorporated into the RCRAInfo data system.

CDL Clandestine Drug Laboratory Locations

VERSION DATE: 07/01/16

The U.S. Department of Justice ("the Department") provides this information as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments. The Department does not establish, implement, enforce, or certify compliance with clean-up or remediation standards for contaminated sites; the public should contact a state or local health department or environmental protection agency for that information.

DOCKETS EPA Docket Data

VERSION DATE: 12/22/05

The United States Environmental Protection Agency Docket data lists Civil Case Defendants, filing dates as far back as 1971, laws broken including section, violations that occurred, pollutants involved, penalties assessed and superfund awards by facility and location. Please refer to ICIS database as source of current data.

EC Federal Engineering Institutional Control Sites

VERSION DATE: 08/03/15

This database includes site locations where Engineering and/or Institutional Controls have been identified as part

of a selected remedy for the site as defined by United States Environmental Protection Agency official remedy decision documents. A site listing does not indicate that the institutional and engineering controls are currently in place nor will be in place once the remedy is complete; it only indicates that the decision to include either of them in the remedy is documented as of the completed date of the document. Institutional controls are actions, such as legal controls, that help minimize the potential for human exposure to contamination by ensuring appropriate land or resource use. Engineering controls include caps, barriers, or other device engineering to prevent access, exposure, or continued migration of contamination.

ECHOR06 Enforcement and Compliance History Information

VERSION DATE: 08/26/17

The EPA's Enforcement and Compliance History Online (ECHO) database, provides compliance and enforcement information for facilities nationwide. This database includes facilities regulated as Clean Air Act stationary sources, Clean Water Act direct dischargers, Resource Conservation and Recovery Act hazardous waste handlers, Safe Drinking Water Act public water systems along with other data, such as Toxics Release Inventory releases.

ERNSTX Emergency Response Notification System

VERSION DATE: 04/17/17

This National Response Center database contains data on reported releases of oil, chemical, radiological, biological, and/or etiological discharges into the environment anywhere in the United States and its territories. The data comes from spill reports made to the U.S. Environmental Protection Agency, U.S. Coast Guard, the National Response Center and/or the U.S. Department of Transportation.

FRSTX Facility Registry System

VERSION DATE: 04/04/17

The United States Environmental Protection Agency's Office of Environmental Information (OEI) developed the Facility Registry System (FRS) as the centrally managed database that identifies facilities, sites or places subject to environmental regulations or of environmental interest. The Facility Registry System replaced the Facility Index System or FINDS database.

HMIRSR06 Hazardous Materials Incident Reporting System

VERSION DATE: 08/30/17

The HMIRS database contains unintentional hazardous materials release information reported to the U.S. Department of Transportation located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

ICIS Integrated Compliance Information System (formerly DOCKETS)

VERSION DATE: 09/23/17

ICIS is a case activity tracking and management system for civil, judicial, and administrative federal Environmental Protection Agency enforcement cases. ICIS contains information on federal administrative and federal judicial cases under the following environmental statutes: the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, the Emergency Planning and Community Right-to-Know Act - Section 313, the Toxic Substances Control Act, the Federal Insecticide, Fungicide, and Rodenticide Act, the Comprehensive Environmental Response, Compensation, and Liability Act, the Safe Drinking Water Act, and the Marine Protection, Research, and Sanctuaries Act.

ICISNPDES Integrated Compliance Information System National Pollutant Discharge Elimination System

VERSION DATE: 07/09/17

Authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

LUCIS Land Use Control Information System

VERSION DATE: 09/01/06

The LUCIS database is maintained by the U.S. Navy and contains information for former Base Realignment and Closure (BRAC) properties across the United States.

MLTS Material Licensing Tracking System

VERSION DATE: 06/29/17

MLTS is a list of approximately 8,100 sites which have or use radioactive materials subject to the United States Nuclear Regulatory Commission (NRC) licensing requirements.

NPDESR06 National Pollutant Discharge Elimination System

VERSION DATE: 04/01/07

Authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES database was collected from December 2002 until April 2007. Refer to the PCS and/or ICIS-NPDES database as source of current data. This database includes permitted facilities located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

PADS PCB Activity Database System

VERSION DATE: 07/18/17

PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

PCSR06 Permit Compliance System

VERSION DATE: 08/01/12

The Permit Compliance System is used in tracking enforcement status and permit compliance of facilities controlled by the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act and is maintained by the United States Environmental Protection Agency's Office of Compliance. PCS is designed to support the NPDES program at the state, regional, and national levels. This database includes permitted facilities located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. PCS has been modernized, and no longer exists. National Pollutant Discharge Elimination System (ICIS-NPDES) data can now be found in Integrated Compliance Information System (ICIS).

RCRASC RCRA Sites with Controls

VERSION DATE: 03/08/16

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities with institutional controls in place.

SEMSLIENS SEMS Lien on Property

VERSION DATE: 07/11/17

The U.S. Environmental Protections Agency's (EPA) Office of Solid Waste and Emergency Response, Office of Superfund Remediation and Technology Innovation (OSRTI), has implemented The Superfund Enterprise Management System (SEMS), formerly known as CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) to track and report on clean-up and enforcement activities taking place at Superfund sites. SEMS represents a joint development and ongoing collaboration between Superfund's Remedial, Removal, Federal Facilities, Enforcement and Emergency Response programs. This is a listing of SEMS sites with a lien on the property.

SFLIENS CERCLIS Liens

VERSION DATE: 06/08/12

A Federal CERCLA ("Superfund") lien can exist by operation of law at any site or property at which United States Environmental Protection Agency has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties. This database contains those CERCLIS sites where the Lien on Property action is complete.

SSTS Section Seven Tracking System

VERSION DATE: 12/08/14

The United States Environmental Protection Agency tracks information on pesticide establishments through the Section Seven Tracking System (SSTS). SSTS records the registration of new establishments and records pesticide production at each establishment. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requires that production of pesticides or devices be conducted in a registered pesticide-producing or device-producing establishment. ("Production" includes formulation, packaging, repackaging, and relabeling.)

TRI Toxics Release Inventory

VERSION DATE: 12/31/15

The Toxics Release Inventory, provided by the United States Environmental Protection Agency, includes data on toxic chemical releases and waste management activities from certain industries as well as federal and tribal facilities. This inventory contains information about the types and amounts of toxic chemicals that are released each year to the air, water, and land as well as information on the quantities of toxic chemicals sent to other facilities for further waste management.

TSCA Toxic Substance Control Act Inventory

VERSION DATE: 12/31/06

The Toxic Substances Control Act (TSCA) was enacted in 1976 to ensure that chemicals manufactured, imported, processed, or distributed in commerce, or used or disposed of in the United States do not pose any unreasonable risks to human health or the environment. TSCA section 8(b) provides the United States Environmental Protection Agency authority to "compile, keep current, and publish a list of each chemical substance that is manufactured or processed in the United States." This TSCA Chemical Substance Inventory contains non-confidential information on the production amount of toxic chemicals from each manufacturer and importer site.

RCRANGR06 Resource Conservation & Recovery Act - Non-Generator

VERSION DATE: 06/12/17

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities classified as non-generators. Non-Generators do not presently generate hazardous waste. EPA Region 6 includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

ALTFUELS Alternative Fueling Stations

VERSION DATE: 05/16/17

Nationwide list of alternative fueling stations made available by the US Department of Energy's Office of Energy Efficiency & Renewable Energy. Includes Biodiesel stations, Ethanol (E85) stations, Liquefied Petroleum Gas (Propane) stations, Ethanol (E85) stations, Natural Gas stations, Hydrogen stations, and Electric Vehicle Supply Equipment (EVSE).

FEMAUST FEMA Owned Storage Tanks

VERSION DATE: 12/01/16

This is a listing of FEMA owned underground and aboveground storage tank sites. For security reasons, address information is not released to the public according to the U.S. Department of Homeland Security.

HISTPST Historical Gas Stations

VERSION DATE: NR

This historic directory of service stations is provided by the Cities Service Company. The directory includes Cities Service filling stations that were located throughout the United States in 1930.

ICISCLEANERS Integrated Compliance Information System Drycleaners

VERSION DATE: 09/23/17

This is a listing of drycleaner facilities from the Integrated Compliance Information System (ICIS). The Environmental Protection Agency (EPA) tracks facilities that possess NAIC and SIC codes that classify businesses as drycleaner establishments.

MRDS Mineral Resource Data System

VERSION DATE: 03/15/16

MRDS (Mineral Resource Data System) is a collection of reports describing metallic and nonmetallic mineral resources throughout the world. Included are deposit name, location, commodity, deposit description, geologic characteristics, production, reserves, resources, and references. This database contains the records previously provided in the Mineral Resource Data System (MRDS) of USGS and the Mineral Availability System/Mineral Industry Locator System (MAS/MILS) originated in the U.S. Bureau of Mines, which is now part of USGS.

MSHA Mine Safety and Health Administration Master Index File

VERSION DATE: 09/01/17

The Mine dataset lists all Coal and Metal/Non-Metal mines under MSHA's jurisdiction since 1/1/1970. It includes such information as the current status of each mine (Active, Abandoned, NonProducing, etc.), the current owner

and operating company, commodity codes and physical attributes of the mine. Mine ID is the unique key for this data. This information is provided by the United States Department of Labor - Mine Safety and Health Administration (MSHA).

RCRAGR06 Resource Conservation & Recovery Act - Generator

VERSION DATE: 06/12/17

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities currently generating hazardous waste. EPA region 6 includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

BF Brownfields Management System

VERSION DATE: 08/17/17

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. The United States Environmental Protection Agency maintains this database to track activities in the various brown field grant programs including grantee assessment, site cleanup and site redevelopment. This database included tribal brownfield sites.

DNPL Delisted National Priorities List

VERSION DATE: 07/11/17

This database includes sites from the United States Environmental Protection Agency's Final National Priorities List (NPL) where remedies have proven to be satisfactory or sites where the original analyses were inaccurate, and the site is no longer appropriate for inclusion on the NPL, and final publication in the Federal Register has occurred.

NLRRCRAT No Longer Regulated RCRA Non-CORRACTS TSD Facilities

VERSION DATE: 06/12/17

This database includes RCRA Non-Corrective Action TSD facilities that are no longer regulated by the United States Environmental Protection Agency or do not meet other RCRA reporting requirements. This listing includes facilities that formerly treated, stored or disposed of hazardous waste.

ODI Open Dump Inventory

VERSION DATE: 06/01/85

The open dump inventory was published by the United States Environmental Protection Agency. An “open dump” is defined as a facility or site where solid waste is disposed of which is not a sanitary landfill which meets the criteria promulgated under section 4004 of the Solid Waste Disposal Act (42 U.S.C. 6944) and which is not a facility for disposal of hazardous waste. This inventory has not been updated since June 1985.

RCRAT Resource Conservation & Recovery Act - Non-CORRACTS Treatment, Storage & Disposal Facilities

VERSION DATE: 06/12/17

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities recognized as hazardous waste treatment, storage, and disposal sites (TSD).

SEMS Superfund Enterprise Management System

VERSION DATE: 07/11/17

The U.S. Environmental Protections Agency's (EPA) Office of Solid Waste and Emergency Response, Office of Superfund Remediation and Technology Innovation (OSRTI), has implemented The Superfund Enterprise Management System (SEMS), formerly known as CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) to track and report on clean-up and enforcement activities taking place at Superfund sites. SEMS represents a joint development and ongoing collaboration between Superfund's Remedial, Removal, Federal Facilities, Enforcement and Emergency Response programs.

SEMSARCH Superfund Enterprise Management System Archived Site Inventory

VERSION DATE: 07/11/17

The Superfund Enterprise Management System Archive listing (SEMS-ARCHIVE) has replaced the CERCLIS NFRAP reporting system in 2015. This listing reflect sites that have been assessed and no further remediation is planned and is of no further interest under the Superfund program.

SMCRA Surface Mining Control and Reclamation Act Sites

VERSION DATE: 08/25/17

An inventory of land and water impacted by past mining (primarily coal mining) is maintained by OSMRE to provide information needed to implement the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The inventory contains information on the location, type, and extent of AML impacts, as well as, information on the cost associated with the reclamation of those problems. The inventory is based upon field surveys by State, Tribal, and OSMRE program officials. It is dynamic to the extent that it is modified as new problems are identified and existing problems are reclaimed.

USUMTRCA Uranium Mill Tailings Radiation Control Act Sites

VERSION DATE: 03/04/17

The Legacy Management Office of the Department of Energy (DOE) manages radioactive and chemical waste, environmental contamination, and hazardous material at over 100 sites across the U.S. The L.M. Office manages this database of sites registered under the Uranium Mill Tailings Control Act (UMTRCA).

DOD Department of Defense Sites

VERSION DATE: 06/21/10

This information originates from the National Atlas of the United States Federal Lands data, which includes lands owned or administered by the Federal government. Army DOD, Army Corps of Engineers DOD, Air Force DOD, Navy DOD and Marine DOD areas of 640 acres or more are included.

FUDS Formerly Used Defense Sites

VERSION DATE: 06/01/15

The Formerly Used Defense Sites (FUDS) inventory includes properties previously owned by or leased to the United States and under Secretary of Defense Jurisdiction, as well as Munitions Response Areas (MRAs). The remediation of these properties is the responsibility of the Department of Defense. This data is provided by the U.S. Army Corps of Engineers (USACE), the boundaries/polygon data are based on preliminary findings and not all properties currently have polygon data available. DISCLAIMER: This data represents the results of data collection/processing for a specific USACE activity and is in no way to be considered comprehensive or to be used in any legal or official capacity as presented on this site. While the USACE has made a reasonable effort to insure the accuracy of the maps and associated data, it should be explicitly noted that USACE makes no warranty, representation or guaranty, either expressed or implied, as to the content, sequence, accuracy, timeliness or completeness of any of the data provided herein. For additional information on Formerly Used Defense Sites please contact the USACE Public Affairs Office at (202) 528-4285.

FUSRAP Formerly Utilized Sites Remedial Action Program

VERSION DATE: 03/04/17

The U.S. DOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to remediate sites where radioactive contamination remained from the Manhattan Project and early U.S. Atomic Energy Commission (AEC) operations. The DOE Office of Legacy Management (LM) established long-term surveillance and maintenance (LTS&M) requirements for remediated FUSRAP sites. DOE evaluates the final site conditions of a remediated site on the basis of risk for different future uses. DOE then confirms that LTS&M requirements will maintain protectiveness.

NLRRCRAC No Longer Regulated RCRA Corrective Action Facilities

VERSION DATE: 06/12/17

This database includes RCRA Corrective Action facilities that are no longer regulated by the United States Environmental Protection Agency or do not meet other RCRA reporting requirements.

NMS Former Military Nike Missile Sites

VERSION DATE: 12/01/84

This information was taken from report DRXTH-AS-IA-83A016 (Historical Overview of the Nike Missile System, 12/1984) which was performed by Environmental Science and Engineering, Inc. for the U.S. Army Toxic and Hazardous Materials Agency Assessment Division. The Nike system was deployed between 1954 and the mid-1970's. Among the substances used or stored on Nike sites were liquid missile fuel (JP-4); starter fluids (UDKH, aniline, and furfuryl alcohol); oxidizer (IRFNA); hydrocarbons (motor oil, hydraulic fluid, diesel fuel, gasoline, heating oil); solvents (carbon tetrachloride, trichloroethylene, trichloroethane, stoddard solvent); and battery electrolyte. The quantities of material a disposed of and procedures for disposal are not documented in published reports. Virtually all information concerning the potential for contamination at Nike sites is confined to personnel who were assigned to Nike sites.
During deactivation most hardware was shipped to depot-level supply points. There were reportedly instances where excess materials were disposed of on or near the site itself at closure. There was reportedly no routine site decontamination.

NPL National Priorities List

VERSION DATE: 07/11/17

This database includes United States Environmental Protection Agency (EPA) National Priorities List sites that fall under the EPA's Superfund program, established to fund the cleanup of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action.

PNPL Proposed National Priorities List

VERSION DATE: 07/11/17

This database contains sites proposed to be included on the National Priorities List (NPL) in the Federal Register. The United States Environmental Protection Agency investigates these sites to determine if they may present long-term threats to public health or the environment.

RCRAC Resource Conservation & Recovery Act - Corrective Action Facilities

VERSION DATE: 06/12/17

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities with corrective action activity.

RCRASUBC Resource Conservation & Recovery Act - Subject to Corrective Action Facilities

VERSION DATE: 06/12/17

The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. This listing refers to facilities subject to corrective actions.

RODS Record of Decision System

VERSION DATE: 01/23/12

These decision documents maintained by the United States Environmental Protection Agency describe the chosen remedy for NPL (Superfund) site remediation. They also include site history, site description, site characteristics, community participation, enforcement activities, past and present activities, contaminated media, the contaminants present, and scope and role of response action.

GWCC Groundwater Contamination Cases

VERSION DATE: 08/26/16

This report contains a listing of groundwater contamination cases which were documented for the 2013 calendar year. Texas Water Code, Section 26.406 requires the annual report to describe the current status of groundwater monitoring activities conducted or required by each agency at regulated facilities or associated with regulated activities. The agencies reporting these contamination cases include the Texas Commission on Environmental Quality, Railroad Commission of Texas, Texas Alliance of Groundwater Districts, and Department of State Health Services.

HISTGWCC Historic Groundwater Contamination Cases

VERSION DATE: 12/31/12

This historic report contains all agency groundwater contamination cases documented from 1994 to 2012. The agencies that reported these contamination cases included the Texas Commission on Environmental Quality, Railroad Commission of Texas, Texas Alliance of Groundwater Districts, and Department of State Health Services.

LIENS TCEQ Liens

VERSION DATE: 06/16/17

Liens filed upon State and/or Federal Superfund Sites by the Texas Commission on Environmental Quality.

MSD Municipal Setting Designations

VERSION DATE: 04/03/17

The Texas Commission on Environmental Quality defines an MSD as an official state designation given to property within a municipality or its extraterritorial jurisdiction that certifies that designated groundwater at the property is not used as potable water, and is prohibited from future use as potable water because that groundwater is contaminated in excess of the applicable potable-water protective concentration level. The prohibition must be in the form of a city ordinance, or a restrictive covenant that is enforceable by the city and filed in the property records. The MSD property can be a single property, multi-property, or a portion of property.

NOV Notice of Violations

VERSION DATE: 02/24/16

This database containing Notice of Violations (NOV) is maintained by the Texas Commission on Environmental Quality. An NOV is a written notification that documents and communicates violations observed during an inspection to the business or individual inspected.

SIEC01 State Institutional/Engineering Control Sites

VERSION DATE: 06/09/17

The Texas Risk Reduction Program (TRRP) requires the placement of institutional controls (e.g., deed notices or restrictive covenants) on affected property in different circumstances as part of completing a response action. In its simplest form, an institutional control (IC) is a legal document that is recorded in the county deed records. In certain circumstances, local zoning or ordinances can serve as an IC. This listing may also include locations where Engineering Controls are in effect, such as a cap, barrier, or other engineering device to prevent access, exposure, or continued migration of contamination. The sites included on this list are regulated by various programs of the Texas Commission on Environmental Quality (TCEQ).

SPILLS Spills Listing

VERSION DATE: 04/13/17

This Texas Commission on Environmental Quality database includes releases of hazardous or potentially hazardous materials into the environment.

TIERII Tier I I Chemical Reporting Program Facilities

VERSION DATE: 12/31/12

The Texas Tier II Chemical Reporting Program in the Department of State Health Services (DSHS) is the state repository for EPCRA-required Emergency Planning Letters (EPLs), which are one-time notifications to the state from facilities that have certain extremely hazardous chemicals in specified amounts. The Program is also the state repository for EPCRA/state-required hazardous chemical inventory reports called Texas Tier Two Reports. This data contains those facility reports for the 2005 through the 2012 calendar years.

DCR Dry Cleaner Registration Database

VERSION DATE: 07/03/17

The database includes dry cleaning drop stations and facilities registered with the Texas Commission on Environmental Quality.

IHW Industrial and Hazardous Waste Sites

VERSION DATE: 07/03/17

Owner and facility information is included in this database of permitted and non-permitted industrial and hazardous waste sites. Industrial waste is waste that results from or is incidental to operations of industry, manufacturing, mining, or agriculture. Hazardous waste is defined as any solid waste listed as hazardous or possesses one or more hazardous characteristics as defined in federal waste regulations. The IHW database is maintained by the Texas Commission on Environmental Quality.

PIHW Permitted Industrial Hazardous Waste Sites

VERSION DATE: 07/03/17

Owner and facility information is included in this database of all permitted industrial and hazardous waste sites. Industrial waste is waste that results from or is incidental to operations of industry, manufacturing, mining, or agriculture. Hazardous waste is defined as any solid waste listed as hazardous or possesses one or more hazardous characteristics as defined in federal waste regulations. Permitted IHW facilities are regulated under 30 Texas Administrative Code Chapter 335 in addition to federal regulations. The IHW database is maintained by the Texas Commission on Environmental Quality.

PST Petroleum Storage Tanks

VERSION DATE: 07/05/17

The Petroleum Storage Tank database is administered by the Texas Commission on Environmental Quality (TCEQ). Both Underground storage tanks (USTs) and Aboveground storage tanks (ASTs) are included in this report. Petroleum Storage Tank registration has been a requirement with the TCEQ since 1986.

APAR Affected Property Assessment Reports

VERSION DATE: 04/24/17

As regulated by the Texas Commission on Environmental Quality, an Affected Property Assessment Report is required when a person is addressing a release of chemical of concern (COC) under 30 TAC Chapter 350, the Texas Risk Reduction Program (TRRP). The purpose of the APAR is to document all relevant affected property information to identify all release sources and COCs, determine the extent of all COCs, identify all transport/exposure pathways, and to determine if any response actions are necessary. The Texas Administrative Code Title 30 §350.4(a)(1) defines affected property as the entire area (i.e. on-site and off-site; including all environmental media) which contains releases of chemicals of concern at concentrations equal to or greater than the assessment level applicable for residential land use and groundwater classification.

BSA Brownfields Site Assessments

VERSION DATE: 09/06/17

The Brownfields Site Assessments database is maintained by the Texas Commission on Environmental Quality (TCEQ). The TCEQ, in close partnership with the U.S. Environmental Protection Agency (EPA) and other federal, state, and local redevelopment agencies, and stakeholders, is facilitating cleanup, transferability, and revitalization of brownfields through the development of regulatory, tax, and technical assistance tools.

CALF Closed & Abandoned Landfill Inventory

VERSION DATE: 11/01/05

The Texas Commission on Environmental Quality, under a contract with Texas State University, and in cooperation with the 24 regional Council of Governments (COGs) in the State, has located over 4,000 closed

and abandoned municipal solid waste landfills throughout Texas. This listing contains "unauthorized sites". Unauthorized sites have no permit and are considered abandoned. The information available for each site varies in detail and this historical information is not updated. Please refer to the specific regional COG for the most current information.

DCRPS Dry Cleaner Remediation Program Sites

VERSION DATE: 09/01/17

This list of DCRP sites is provided by the Texas Commission on Environmental Quality (TCEQ). According to the TCEQ, the Dry Cleaner Remediation Program (DCRP) establishes a prioritization list of dry cleaner sites and administers the Dry Cleaning Remediation fund to assist with remediation of contamination caused by dry cleaning solvents.

IOP Innocent Owner / Operator Database

VERSION DATE: 06/09/17

Texas Innocent Owner / Operator (IOP), created by House Bill 2776 of the 75th Legislature, provides a certificate to an innocent owner or operator if their property is contaminated as a result of a release or migration of contaminants from a source or sources not located on the property, and they did not cause or contribute to the source or sources of contamination. The IOP database is maintained by the Texas Commission on Environmental Quality.

LPST Leaking Petroleum Storage Tanks

VERSION DATE: 09/06/17

The Leaking Petroleum Storage Tank listing is derived from the Petroleum Storage Tank (PST) database and is maintained by the Texas Commission on Environmental Quality. This listing includes aboveground and underground storage tank facilities with reported leaks.

MSWLF Municipal Solid Waste Landfill Sites

VERSION DATE: 07/07/17

The municipal solid waste landfill database is provided by the Texas Commission on Environmental Quality. This database includes active landfills and inactive landfills, where solid waste is treated or stored.

RRCVCP Railroad Commission VCP and Brownfield Sites

VERSION DATE: 04/11/17

According to the Railroad Commission of Texas, their Voluntary Cleanup Program (RRC-VCP) provides an incentive to remediate Oil & Gas related pollution by participants as long as they did not cause or contribute to the contamination. Applicants to the program receive a release of liability to the state in exchange for a successful cleanup.

RWS Radioactive Waste Sites

VERSION DATE: 07/11/06

This Texas Commission on Environmental Quality database contains all sites in the State of Texas that have been designated as Radioactive Waste sites.

STCV Salt Caverns for Petroleum Storage

VERSION DATE: 09/01/06

The salt caverns for petroleum storage database is provided by the Railroad Commission of Texas.

VCP Voluntary Cleanup Program Sites

VERSION DATE: 09/06/17

The Texas Voluntary Cleanup Program (VCP) provides administrative, technical, and legal incentives to encourage the cleanup of contaminated sites in Texas. Since all non-responsible parties, including future lenders and landowners, receive protection from liability to the state of Texas for cleanup of sites under the VCP, most of the constraints for completing real estate transactions at those sites are eliminated. As a result, many unused or underused properties may be restored to economically productive or community beneficial uses. The VCP database is maintained by the Texas Commission on Environmental Quality.

WMRF Recycling Facilities

VERSION DATE: 11/01/12

This listing of recycling facilities is provided by the Texas Commission on Environmental Quality's Recycle Texas Online service. The company information provided in this database is self-reported. Since recyclers post their own information, a facility or company appearing on the list does not imply that it is in compliance with TCEQ regulations or other applicable laws. This database is no longer maintained and includes the last compilation of the program participants before the Recycle Texas Online program was closed.

IHWCA Industrial and Hazardous Waste Corrective Action Sites

VERSION DATE: 07/14/17

This database is provided by the Texas Commission on Environmental Quality (TCEQ). According to the TCEQ, the mission of the industrial and hazardous waste corrective action program is to oversee the cleanup of sites contaminated from industrial and municipal hazardous and industrial nonhazardous wastes. The goals of this program are to: Ensure that sites are assessed and remediated to levels that protect human health and the environment; Verify that waste management units or facilities are taken out of service and closed properly; and to Facilitate revitalization of contaminated properties.

SF State Superfund Sites

VERSION DATE: 09/23/16

The state Superfund program mission is to remediate abandoned or inactive sites within the state that pose an unacceptable risk to public health and safety or the environment, but which do not qualify for action under the federal Superfund program (NPL - National Priority Listing). As required by the Texas Solid Waste Disposal Act, Texas Health and Safety Code, Chapter 361, the Texas Commission on Environmental Quality identifies and evaluates these facilities for inclusion on the state Superfund registry. This registry includes any recent developments and the anticipated action for these sites.

EAP Edwards Aquifer Permits

VERSION DATE: 07/21/06

This database, maintained by the Texas Commission on Environmental Quality, contains Edward Aquifer permits.

Environmental Records Definitions - TRIBAL

USTR06 Underground Storage Tanks On Tribal Lands

VERSION DATE: 04/24/17

This database, provided by the United States Environmental Protection Agency (EPA), contains underground storage tanks on Tribal lands located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

LUSTR06 Leaking Underground Storage Tanks On Tribal Lands

VERSION DATE: 04/24/17

This database, provided by the United States Environmental Protection Agency (EPA), contains leaking underground storage tanks on Tribal lands located in EPA Region 6. This region includes the following states: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

ODINDIAN Open Dump Inventory on Tribal Lands

VERSION DATE: 11/08/06

This Indian Health Service database contains information about facilities and sites on tribal lands where solid waste is disposed of, which are not sanitary landfills or hazardous waste disposal facilities, and which meet the criteria promulgated under section 4004 of the Solid Waste Disposal Act (42 U.S.C. 6944).

INDIANRES Indian Reservations

VERSION DATE: 01/01/00

The Department of Interior and Bureau of Indian Affairs maintains this database that includes American Indian Reservations, off-reservation trust lands, public domain allotments, Alaska Native Regional Corporations and Recognized State Reservations.

APPENDIX E
CREDENTIALS

SARAH R. SCHWERDFEGER
ENVIRONMENTAL PROJECT MANAGER

PROFESSIONAL EXPERIENCE

Ms. Schwerdfeger has experience performing Phase I Environmental Site Assessments for vacant tracts, office buildings, apartments, downtown properties, and commercial facilities throughout Austin and surrounding area. She writes Phase I Environmental Site Assessments, researches city directories, historical fire insurance maps, and regulatory agency files, and reviews aerial photographs and topographic maps.

PROJECT EXPERIENCE

Villas on Town Lake Condominiums– Austin, Texas

Conducted an ESA for a developed tract of land totaling approximately 2.0 acres located at 80 Red River Street in downtown Austin. The purpose for the ESA was to identify recognized environmental conditions for the client who was considering purchasing the land.
Professional Services Conducted: Environmental Site Assessment
Services Completed: 2017

Proposed Solar Farm - Marlin, Texas

Conducted an ESA for a 50.44 acre tract of vacant, undeveloped, agricultural land at the corner of State Highway 6 and County Road 220 in Marlin, Texas. The purpose for the ESA was to identify recognized environmental conditions for the client who was considering purchasing the property.
Professional Services Conducted: Environmental Site Assessment
Services Completed: 2017

Multi-Use Building- San Marcos, Texas

Conducted an ESA for a 0.3029 acre tract of land improved with a two-story multi-use building at 202 North LBJ Drive in San Marcos, Texas. The purpose for the ESA was to identify recognized environmental conditions for the client who was considering purchasing the property.
Professional Services Conducted: Environmental Site Assessment
Services Completed: 2017

Multi-Family Living- Austin, Texas

Conducted an ESA for a 9.62 acre tract of vacant, undeveloped land located on North Lake Creek Parkway in Austin, Texas. The purpose for the ESA was to identify recognized environmental conditions for the client who was considering purchasing the property.
Professional Services Conducted: Environmental Site Assessment
Services Completed: 2017

University Boulevard- Round Rock, Texas

Conducted an ESA for a 3.158 acre tract of vacant, undeveloped land located at the northeast corner of University Boulevard and Seton Parkway in Round Rock, Texas. The purpose for the ESA was to identify recognized environmental conditions for the client who was considering purchasing the property.
Professional Services Conducted: Environmental Site Assessment
Services Completed: 2017

Education

Bachelor of Science, Bioenvironmental Science, Texas A&M University, 2016

Work History

Terracon Consultants, Inc., Assistant Scientist, January 2017-present

Terracon

RHONDA L. ALFORD
SENIOR ENVIRONMENTAL PROJECT MANAGER

PROFESSIONAL EXPERIENCE

Ms. Alford has more than 20 years of experience in environmental services and currently serves as Department Manager of Environmental Site Assessment (ESA) services for Terracon's Austin office. Ms. Alford is a designated Environmental Professional (as defined by the AAI Final Rule/ASTM E 1527-13) and is a Terracon Authorized Project Reviewer. She serves in a consulting and review capacity to ensure quality standards are met and communicated to clients. She has performed and supervised over a thousand Phase I ESAs throughout the southeastern United States.

Ms. Alford currently oversees a staff of five and supervises the preparation of approximately 30 ESAs per month. Frequently, these ESAs include additional services including asbestos inspections, lead-based paint inspections, lead in drinking water testing, radon testing and mold assessments.

Ms. Alford is an Environmental Protection Agency (EPA) accredited and Texas Department of State Health Services (DSHS) licensed asbestos inspector. She has conducted an extensive number of asbestos inspections of various facility types.

Ms. Alford has also performed and supervised many wetland determinations/delineations primarily in Texas as a result of potential land development. She has extensive field experience in identifying hydrophytic plant species, soil classification, and evaluating hydrological conditions, and has a comprehensive understanding of wetland regulations.

PROJECT EXPERIENCE

Highland Mall – Austin, Texas

Conducted ESAs for four tracts of land totaling approximately 80 acres which comprise the existing Highland Mall, the first mall constructed in Austin in the 1970s. The square footage of the retail project included over 1 million square feet and consisted of four multi-story department stores, two-levels of smaller retail spaces, a stand-alone former movie theatre, a stand-along multi-tenant retail building, an automotive repair/service facility, associated parking areas, and several tracts of undeveloped land. Terracon's client was RedLeaf Properties, Inc. This ESA work lead to additional environmental work including a limited subsurface investigation.
Professional Services Completed: Environmental Site Assessments
Services Completed: 2010-2011
Terracon Fee: $12,800

The Domain Mixed Use Development – Austin, Texas

Conducted 10 ESAs for numerous parcels of land which were part of the former IBM plant. This plant operated from the late 1960s through the early 2000s and manufactured electronic components during its operation. The approximate 175 acre manufacturing plant was subsequently redeveloped with a mixed-use urban development known as The Domain. IBM was very proactive regarding environmental compliance and installed

EDUCATION

Bachelor of Science, Horticulture Science, 1989, Texas A&M University

AFFILIATIONS

Texas Association of Environmental Professionals

CERTIFICATIONS

EPA Accredited Asbestos Inspector

TDSHS Licensed Asbestos Inspector

40 Hour OSHA Hazardous Waste Operations & Emergency Response Training

38 Hour Army Corps of Engineers Wetland Delineation, Management, & Field Trianing Program

WORK HISTORY

Terracon, ESA Services, Department Manager, 1994-present

Southwestern Laboratories, Project Manager, Environmental Consulting Division, 1992-1994

Texas Department of Transportation, Environmental Scientist, 1990-1992

over 300 groundwater monitoring wells across the 175 acre facility. The preparation of these ESAs required an extensive review and evaluation of regulatory information. The ESAs included the inspection of IBMs main office complex (seven multi-story office buildings and parking garages; approx.. 1.1. million square feet), vacant tracts of land (formerly occupied by various manufacturing buildings including a waste water treatment plant), and a branch bank. Terracon's extensive regulatory knowledge of the former IBM plant was a clear advantage in winning this work. Clients for these projects included, but was not limited to, Endeavor Real Estate Group, GS&C Architects, Orix Capital Markets, LLC, Randolph Brooks Federal Credit Union, Domain Parkside I, LP, Streetlights Residential, Columbus Realty Partners, Ltd., Edge Realty Partners, and Novare-AU Austin Development, LLC. This ESA work lead to additional environmental work including limited subsurface investigations.
Professional Services Completed: Environmental Site Assessments
Services Completed: 2010-2011
Terracon Fee: $27,400

Office Building & Parking Garage – Austin, Texas

Conducted an ESA for an office building and parking garage located on two downtown city blocks. The blocks were improved with a 15-story plus basement, 325,000 square foot office building, seven-level, 675 space parking garage and motor bank, and subgrade pedestrian tunnel connecting the two site structures. The ESA identified an on-site former dry cleaning facility and former on-site historical underground storage tank. Terracon's client was the Travis County Facilities Management Department. This results of the ESA lead to additional environmental work including a limited subsurface investigation.
Professional Services Completed: Environmental Site Assessment
Services Completed: 2011
Terracon Fee: $5,200

Apartment Portfolio – Austin, Texas

Conducted an ESA for two apartment complexes with the scope including asbestos sampling, radon sampling, and lead in drinking water sampling. The apartment complexes included Verde Brushy Creek Apartments, a 23 building, 272 unit apartment complex located on approximately 14 acres, and Verde Shadow Brook Apartments, a 43 building, 496 unit apartment complex located on approximately 30 acres. Terracon's client was Camden Multifamily Value Add Fund, L.P. Based on the results of the ESAs, additional radon sampling was conducted at the Verde Brushy Creek site and visible mold growth was identified at the Verde Shadow Brook site.
Professional Services Completed: Environmental Site Assessment, Asbestos Survey, Radon Sampling, Lead in Drinking Water Sampling
Services Completed: 2011
Terracon Fee: $11,200

Lockheed Tract – Austin, Texas

Performed a wetland assessment/delineation on an approximate 700-acre tract of partially developed land which included numerous ponds/livestock tanks and over 13,500 linear feet of stream channel for proposed development. Subsequent to the wetland assessment/delineation, a Section 404 Permit Application was completed and submitted to the USACE. .
Professional Services Completed: Wetland Assessment/Delineation/Permit Submittal
Services Completed: 2002
Terracon Fee: $8,000

ADDITIONAL COURSES

Federal Wetland Regulation; Wetland Training Institute

Wetland Delineation Course as a prerequisite for the US Army Corps of Engineers Wetland Certification Program; Wetland Training Institute

The New and Modified Nationwide 404 Permits; Austin Branch ASCE

APPENDIX F
DESCRIPTION OF TERMS AND ACRONYMS

Description of Selected General Terms and Acronyms

Term/Acronym	*Description*
ACM	Asbestos Containing Material. Asbestos is a naturally occurring mineral, three varieties of which (chrysotile, amosite, crocidolite) have been commonly used as fireproofing or binding agents in construction materials. Exposure to asbestos, as well as ACM, has been documented to cause lung diseases including asbestosis (scarring of the lung), lung cancer and mesothelioma (a cancer of the lung lining). Regulatory agencies have generally defined ACM as a material containing greater that one (1) percent asbestos, however some states (e.g. California) define ACM as materials having 0.1% asbestos. In order to define a homogenous material as non-ACM, a minimum number of samples must be collected from the material dependent upon its type and quantity. Homogenous materials defined as non-ACM must either have 1) no asbestos identified in all of its samples or 2) an identified asbestos concentration below the appropriate regulatory threshold. Asbestos concentrations are generally determined using polarized light microscopy or transmission electron microscopy. Point counting is an analytical method to statistically quantify the percentage of asbestos in a sample. The asbestos component of ACM may either be friable or non-friable. Friable materials, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure and have a higher potential for a fiber release than non-friable ACM. Non-friable ACM are materials that are firmly bound in a matrix by plastic, cement, etc. and, if handled carefully, will not become friable. Federal and state regulations require that either all suspect building materials be presumed ACM or that an asbestos survey be performed prior to renovation, dismantling, demolition, or other activities that may disturb potential ACM. Notifications are required prior to demolition and/or renovation activities that may impact the condition of ACM in a building. ACM removal may be required if the ACM is likely to be disturbed or damaged during the demolition or renovation. Abatement of friable or potentially friable ACM must be performed by a licensed abatement contractor in accordance with state rules and NESHAP. Additionally, OSHA regulations for work classification, worker training and worker protection will apply.
AHERA	Asbestos Hazard Emergency Response Act
AST	Aboveground Storage Tanks. ASTs are generally described as storage tanks less than 10% of which are below ground (i.e., buried). Tanks located in a basement, but not buried, are also considered ASTs. Whether, and the extent to which, an AST is regulated, is determined on a case-by-case basis and depends upon tank size, its contents and the jurisdiction of its location.
BGS	Below Ground Surface
Brownfields	State and/or tribal listing of Brownfield properties addressed by Cooperative Agreement Recipients or Targeted Brownfields Assessments.
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes. BTEX are VOC components found in gasoline and commonly used as analytical indicators of a petroleum hydrocarbon release.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (a.k.a. Superfund). CERCLA is the federal act that regulates abandoned or uncontrolled hazardous waste sites. Under this Act, joint and several liability may be imposed on potentially responsible parties for cleanup-related costs.
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System. An EPA compilation of sites having suspected or actual releases of hazardous substances to the environment. CERCLIS also contains information on site inspections, preliminary assessments and remediation of hazardous waste sites. These sites are typically reported to EPA by states and municipalities or by third parties pursuant to CERCLA Section 103.
CESQG	Conditionally Exempt Small Quantity Generators
CFR	Code of Federal Regulations

Description of Selected General Terms and Acronyms

Term/Acronym	*Description*
CREC	Controlled Recognized Environmental Condition is defined in ASTM E1527-13 as "a recognized environmental condition resulting from a past release of hazardous substances or petroleum products that has been addressed to the satisfaction of the applicable regulatory authority (for example, as evidenced by the issuance of a no further action letter or equivalent, or meeting risk-based criteria established by regulatory authority) , with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls (for example, property use restrictions, activity and use limitations, institutional controls, or engineering controls). A condition considered by the environmental professional to be a controlled recognized environmental condition shall be listed in the findings section of the Phase I Environmental Site Assessment report, and as a recognized environmental condition in the conclusions section of the Phase I Environmental Site Assessment report."
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ERNS	Emergency Response Notification System. An EPA-maintained federal database which stores information on notifications of oil discharges and hazardous substance releases in quantities greater than the applicable reportable quantity under CERCLA. ERNS is a cooperative data-sharing effort between EPA, DOT, and the National Response Center.
ESA	Environmental Site Assessment
FRP	Fiberglass Reinforced Plastic
Hazardous Substance	As defined under CERCLA, this is (A) any substance designated pursuant to section 1321(b)(2)(A) of Title 33, (B) any element, compound, mixture, solution, or substance designated pursuant to section 9602 of this title; (C) any hazardous waste having characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act (with some exclusions); (D) any toxic pollutant listed under section 1317(a) of Title 33; (E) any hazardous air pollutant listed under section 112 of the Clean Air Act; and (F) any imminently hazardous chemical substance or mixture with respect to which the EPA Administrator has taken action under section 2606 of Title 15. This term does not include petroleum, including crude oil or any fraction thereof which is not otherwise listed as a hazardous substance under subparagraphs (A) through (F) above, and the term include natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).
Hazardous Waste	This is defined as having characteristics identified or listed under section 3001 of the Solid Waste Disposal Act (with some exceptions). RCRA, as amended by the Solid Waste Disposal Act of 1980, defines this term as a "solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."
HREC	Historical Recognized Environmental Condition is defined in ASTM E1527-13 as "a past release of any hazardous substances or petroleum products that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authority or meeting unrestricted residential use criteria established by a regulatory authority, without subjecting the property to any required controls (for example, property use restrictions, activity and use limitations, institutional controls, or engineering controls). Before calling the past release a historical recognized environmental condition, the environmental professional must determine whether the past release is a recognized environmental condition at the time of the Phase I Environmental Site Assessment is conducted (for example, if there has been a change in the regulatory criteria). If the EP considers the past release to be a recognized environmental condition at the time the Phase I ESA is conducted, the condition shall be included in the conclusions section of the report as a recognized environmental condition."
IC/EC	A listing of sites with institutional and/or engineering controls in place. IC include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls. EC include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.
ILP	Innocent Landowner/Operator Program
LQG	Large Quantity Generators
LUST	Leaking Underground Storage Tank. This is a federal term set forth under RCRA for leaking USTs. Some states also utilize this term.

Description of Selected General Terms and Acronyms

Term/Acronym	*Description*
MCL	Maximum Contaminant Level. This Safe Drinking Water concept (and also used by many states as a ground water cleanup criteria) refers to the limit on drinking water contamination that determines whether a supplier can deliver water from a specific source without treatment.
MSDS	Material Safety Data Sheets. Written/printed forms prepared by chemical manufacturers, importers and employers which identify the physical and chemical traits of hazardous chemicals under OSHA's Hazard Communication Standard.
NESHAP	National Emissions Standard for Hazardous Air Pollutants (Federal Clean Air Act). This part of the Clean Air Act regulates emissions of hazardous air pollutants.
NFRAP	Facilities where there is "No Further Remedial Action Planned," as more particularly described under the Records Review section of this report.
NOV	Notice of Violation. A notice of violation or similar citation issued to an entity, company or individual by a state or federal regulatory body indicating a violation of applicable rule or regulations has been identified.
NPDES	National Pollutant Discharge Elimination System (Clean Water Act). The federal permit system for discharges of polluted water.
NPL	The NPL is the EPA's database of uncontrolled or abandoned hazardous waste facilities that have been listed for priority remedial actions under the Superfund Program.
OSHA	Occupational Safety and Health Administration or Occupational Safety and Health Act
PACM	Presumed Asbestos-Containing Material. A material that is suspected of containing or presumed to contain asbestos but which has not been analyzed to confirm the presence or absence of asbestos.
PCB	Polychlorinated Biphenyl. A halogenated organic compound commonly in the form of a viscous liquid or resin, a flowing yellow oil, or a waxy solid. This compound was historically used as dielectric fluid in electrical equipment (such as electrical transformers and capacitors, electrical ballasts, hydraulic and heat transfer fluids), and for numerous heat and fire sensitive applications. PCB was preferred due to its durability, stability (even at high temperatures), good chemical resistance, low volatility, flammability, and conductivity. PCBs, however, do not break down in the environment and are classified by the EPA as a suspected carcinogen. 1978 regulations, under the Toxic Substances Control Act, prohibit manufacturing of PCB-containing equipment; however, some of this equipment may still be in use today.
pCi/L	picoCuries per Liter of Air. Unit of measurement for Radon and similar radioactive materials.
PLM	Polarized Light Microscopy (see ACM section of the report, if included in the scope of services)
PST	Petroleum Storage Tank. An AST or UST that contains a petroleum product.
Radon	A radioactive gas resulting from radioactive decay of naturally-occurring radioactive materials in rocks and soils containing uranium, granite, shale, phosphate, and pitchblende. Radon concentrations are measured in picoCuries per Liter of Air. Exposure to elevated levels of radon creates a risk of lung cancer; this risk generally increases as the level of radon and the duration of exposure increases. Outdoors, radon is diluted to such low concentrations that it usually does not present a health concern. However, radon can accumulate in building basements or similar enclosed spaces to levels that can pose a risk to human health. Indoor radon concentrations depend primarily upon the building's construction, design and the concentration of radon in the underlying soil and ground water. The EPA recommended annual average indoor "action level" concentration for residential structures is 4.0 pCi/l.
RCRA	Resource Conservation and Recovery Act. Federal act regulating solid and hazardous wastes from point of generation to time of disposal ('cradle to grave"). 42 U.S.C. 6901 et seq.
RCRA Generators	The RCRA Generators database, maintained by the EPA, lists facilities that generate hazardous waste as part of their normal business practices. Generators are listed as either large (LQG), small (SQG), or conditionally exempt (CESQG). LQG produce at least 1000 kg/month of non-acutely hazardous waste or 1 kg/month of acutely hazardous waste. SQG produce 100-1000 kg/month of non-acutely hazardous waste. CESQG are those that generate less than 100 kg/month of non-acutely hazardous waste.
RCRA CORRACTS/TSDs	The USEPA maintains a database of RCRA facilities associated with treatment, storage, and disposal (TSD) of hazardous materials which are undergoing "corrective action". A "corrective action" order is issued when there is a release of hazardous waste or constituents into the environment from a RCRA facility.
RCRA Non-CORRACTS/TSDs	The RCRA Non-CORRACTS/TSD Database is a compilation by the USEPA of facilities which report storage, transportation, treatment, or disposal of hazardous waste. Unlike the RCRA CORRACTS/TSD database, the RCRA Non-CORRACTS/TSD database does not include RCRA facilities where corrective action is required.

Description of Selected General Terms and Acronyms

Term/Acronym	*Description*
RCRA Violators List	RAATS. RCRA Administrative Actions Taken. RAATS information is now contained in the RCRIS database and includes records of administrative enforcement actions against facilities for noncompliance.
RCRIS	Resource Conservation and Recovery Information System, as defined in the Records Review section of this report.
REC	Recognized Environmental Conditions are defined by ASTM E1527-13 as "the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: 1) due to any release to the environment; 2) under conditions indicative of a release to the environment. *De minimis* conditions are not recognized environmental conditions."
SCL	State "CERCLIS" List (see SPL /State Priority List, below).
SPCC	Spill Prevention, Control and Countermeasures. SPCC plans are required under federal law (Clean Water Act and Oil Pollution Act) for any facility storing petroleum in tanks and/or containers of 55-gallons or more that when taken in aggregate exceed 1,320 gallons. SPCC plans are also required for facilities with underground petroleum storage tanks with capacities of over 42,000 gallons. Many states have similar spill prevention programs, which may have additional requirements.
SPL	State Priority List. State list of confirmed sites having contamination in which the state is actively involved in clean up activities or is actively pursuing potentially responsible parties for clean up. Sometimes referred to as a State "CERCLIS" List.
SQG	Small Quantity Generator
SWF/LF	State and/or Tribal database of Solid Waste/Landfill facilities. The database information may include the facility name, class, operation type, area, estimated operational life, and owner.
TPH	Total Petroleum Hydrocarbons
TRI	Toxic Release Inventory. Routine EPA report on releases of toxic chemicals to the environment based upon information submitted by entities subject to reporting under the Emergency Planning and Community Right to Know Act.
TSCA	Toxic Substances Control Act. A federal law regulating manufacture, import, processing and distribution of chemical substances not specifically regulated by other federal laws (such as asbestos, PCBs, lead-based paint and radon). 15 U.S.C 2601 et seq.
USACE	United States Army Corps of Engineers
USC	United States Code
USGS	United States Geological Survey
USNRCS	United States Department of Agriculture-Natural Resource Conservation Service
UST	Underground Storage Tank. Most federal and state regulations, as well as ASTM E1527-13, define this as any tank, incl., underground piping connected to the tank, that is or has been used to contain hazardous substances or petroleum products and the volume of which is 10% or more beneath the surface of the ground (i.e., buried).
VCP	State and/or Tribal facilities included as Voluntary Cleanup Program sites.
VOC	Volatile Organic Compound

Description of Selected General Terms and Acronyms

Term/Acronym	*Description*
Wetlands	Areas that are typically saturated with surface or ground water that creates an environment supportive of wetland vegetation (i.e., swamps, marshes, bogs). The Corps of Engineers Wetlands Delineation Manual (Technical Report Y-87-1) defines wetlands as areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. For an area to be considered a jurisdictional wetland, it must meet the following criteria: more than 50 percent of the dominant plant species must be categorized as Obligate, Facultative Wetland, or Facultative on lists of plant species that occur in wetlands; the soil must be hydric; and, wetland hydrology must be present. The federal Clean Water Act which regulates "waters of the US," also regulates wetlands, a program jointly administered by the USACE and the EPA. Waters of the U.S. are defined as: (1) waters used in interstate or foreign commerce, including all waters subject to the ebb and flow of tides; (2) all interstate waters including interstate wetlands; (3) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, etc., which the use, degradation, or destruction could affect interstate/ foreign commerce; (4) all impoundments of waters otherwise defined as waters of the U. S., (5) tributaries of waters identified in 1 through 4 above; (6) the territorial seas; and (7) wetlands adjacent to waters identified in 1 through 6 above. Only the USACE has the authority to make a final wetlands jurisdictional determination.

Geologic Assessment

Texas Commission on Environmental Quality

For Regulated Activities on The Edwards Aquifer Recharge/transition Zones and Relating to 30 TAC §213.5(b)(3), Effective June 1, 1999

To ensure that the application is administratively complete, confirm that all fields in the form are complete, verify that all requested information is provided, consistently reference the same site and contact person in all forms in the application, and ensure forms are signed by the appropriate party.

Note: Including all the information requested in the form and attachments contributes to more streamlined technical reviews.

Signature

To the best of my knowledge, the responses to this form accurately reflect all information requested concerning the proposed regulated activities and methods to protect the Edwards Aquifer. My signature certifies that I am qualified as a geologist as defined by 30 TAC Chapter 213.

Print Name of Geologist: Russell C Ford Telephone: 512 442-1122

Date: 10/27/17 Fax: _____

Representing: Terracon Consultants, Inc. (Name of Company and TBPG or TBPE registration number)

Signature of Geologist:

Regulated Entity Name: Proposed Fire Station #7, 2703 E Highway 29, Georgetown, Texas

Project Information

1. Date(s) Geologic Assessment was performed: 10/13/17
2. Type of Project:
   - ☒ WPAP
   - ☐ SCS
   - ☐ AST
   - ☐ UST
3. Location of Project:
   - ☒ Recharge Zone
   - ☒ Transition Zone
   - ☐ Contributing Zone within the Transition Zone

10/27/17

STATE OF TEXAS
Russell C. Ford
GEOLOGY
#1185
LICENSED
PROFESSIONAL GEOSCIENTIST

4. ☒ **Attachment A - Geologic Assessment Table**. Completed Geologic Assessment Table (Form TCEQ-0585-Table) is attached.

5. ☒ Soil cover on the project site is summarized in the table below and uses the SCS Hydrologic Soil Groups* (Urban Hydrology for Small Watersheds, Technical Release No. 55, Appendix A, Soil Conservation Service, 1986). If there is more than one soil type on the project site, show each soil type on the site Geologic Map or a separate soils map.

Table 1 - Soil Units, Infiltration Characteristics and Thickness

Soil Name	Group*	Thickness(feet)
HeD2	D	2-4
HsE	D	2-4
KsA	D	2-4
SuB	B	3-5

* *Soil Group Definitions (Abbreviated)*

A. *Soils having a high infiltration rate when thoroughly wetted.*
B. *Soils having a moderate infiltration rate when thoroughly wetted.*
C. *Soils having a slow infiltration rate when thoroughly wetted.*
D. *Soils having a very slow infiltration rate when thoroughly wetted.*

6. ☒ **Attachment B – Stratigraphic Column.** A stratigraphic column showing formations, members, and thicknesses is attached. The outcropping unit, if present, should be at the top of the stratigraphic column. Otherwise, the uppermost unit should be at the top of the stratigraphic column.

7. ☒ **Attachment C – Site Geology**. A narrative description of the site specific geology including any features identified in the Geologic Assessment Table, a discussion of the potential for fluid movement to the Edwards Aquifer, stratigraphy, structure(s), and karst characteristics is attached.

8. ☒ **Attachment D – Site Geologic Map(s)**. The Site Geologic Map must be the same scale as the applicant's Site Plan. The minimum scale is 1": 400'

   Applicant's Site Plan Scale: 1" = _'
   Site Geologic Map Scale: 1" = 100'
   Site Soils Map Scale (if more than 1 soil type): 1" = 100 '

9. Method of collecting positional data:

   ☒ Global Positioning System (GPS) technology.
   ☐ Other method(s). Please describe method of data collection: _____

10. ☒ The project site and boundaries are clearly shown and labeled on the Site Geologic Map.

11. ☒ Surface geologic units are shown and labeled on the Site Geologic Map.

12. ☒ Geologic or manmade features were discovered on the project site during the field investigation. They are shown and labeled on the Site Geologic Map and are described in the attached Geologic Assessment Table.

    ☐ Geologic or manmade features were not discovered on the project site during the field investigation.

13. ☒ The Recharge Zone boundary is shown and labeled, if appropriate.

14. All known wells (test holes, water, oil, unplugged, capped and/or abandoned, etc.): If applicable, the information must agree with Item No. 20 of the WPAP Application Section.

    ☒ There are 1 (#) wells present on the project site and the locations are shown and labeled. (Check all of the following that apply.)
    - ☐ The wells are not in use and have been properly abandoned.
    - ☐ The wells are not in use and will be properly abandoned.
    - ☒ The wells are in use and comply with 16 TAC Chapter 76.

    ☐ There are no wells or test holes of any kind known to exist on the project site.

Administrative Information

15. ☒ Submit one (1) original and one (1) copy of the application, plus additional copies as needed for each affected incorporated city, groundwater conservation district, and county in which the project will be located. The TCEQ will distribute the additional copies to these jurisdictions. The copies must be submitted to the appropriate regional office.

ATTACHMENT A

GEOLOGIC ASSESSMENT TABLE

PROJECT NAME: Proposed Fire Station #7, 2703 E Highway 29, Georgetown, Texas

LOCATION			FEATURE CHARACTERISTICS											EVALUATION			PHYSICAL SETTING		
1A	1B *	1C*	2A	2B	3	4			5	5A	6	7	8A	8B	9	10		11		12
FEATURE ID	LATITUDE	LONGITUDE	FEATURE TYPE	POINTS	FORMATION	DIMENSIONS (FEET)			TREND (DEGREES)	DOM	DENSITY (NO/FT)	APERTURE (FEET)	INFILL	RELATIVE INFILTRATION RATE	TOTAL	SENSITIVITY		CATCHMENT AREA (ACRES)		TOPOGRAPHY
						X	Y	Z		10						<40	>40	<1.6	>1.6	
WW-1	30.6392	-97.6463	MB	30	Kbu									10	X		X	X		Hilltop

* DATUM NAD27

2A TYPE	TYPE	2B POINTS
C	Cave	30
SC	Solution cavity	20
SF	Solution-enlarged fracture(s)	20
F	Fault	20
O	Other natural bedrock features	5
MB	Manmade feature in bedrock	30
SW	Swallow hole	30
SH	Sinkhole	20
CD	Non-karst closed depression	5
Z	Zone, clustered or aligned features	30

8A INFILLING	
N	None, exposed bedrock
C	Coarse - cobbles, breakdown, sand, gravel
O	Loose or soft mud or soil, organics, leaves, sticks, dark colors
F	Fines, compacted clay-rich sediment, soil profile, gray or red colors
V	Vegetation. Give details in narrative description
FS	Flowstone, cements, cave deposits
X	Other materials

12 TOPOGRAPHY
Cliff, Hilltop, Hillside, Drainage, Floodplain, Streambed

I have read, I understood, and I have followed the Texas Natural Resource Conservation Commission's Instructions to Geologists. The information presented here complies with that document and is a true representation of the conditions observed in the field.

My signature certifies that I am qualified as a geologist as defined by 30 TAC 213

Date 10/27/17

TNRCC-0585-Table (Rev. 5-1-02)

Sheet 1 of 1

STATE OF TEXAS
Russell C. Ford
GEOLOGY
#1185
LICENSED
PROFESSIONAL GEOSCIENTIST

ATTACHMENT B

Stratigraphic Column
Proposed Fire Station #7
2703 E Highway 29
Georgetown, Texas

HYDROGEOLOGIC SUBDIVISION	FORMATION	THICKNESS (feet)	LITHOLOGY
Confining Unit	Quaternary alluvium	15	Unconsolidated silt, sand and gravel
	Buda Formation	25	Tan, very hard, coarse grained, crystalline limestone

Source: Senger, Collins and Kreitler, 1990

10/27/17

STATE OF TEXAS
Russell C. Ford
GEOLOGY
#1185
LICENSED
PROFESSIONAL GEOSCIENTIST

ATTACHMENT C
SITE-SPECIFIC GEOLOGY

The Geologic Assessment (GA) of the proposed Fire Station #7 site was performed by Mr. Russell C. Ford, P.G., of Terracon on October 13, 2017. The site is located at 2703 E Highway 29, in Georgetown, Texas, and consists of an approximate 6.04-acre tract of land improved with a residence, towing and recovery company, and automotive service shop with associated storage sheds, and unimproved drives and parking areas

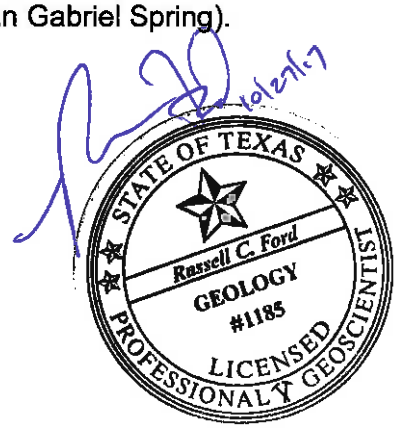
Exhibit 1 (attached) is a site location map depicting the site in relation to the surrounding area. The areas immediately surrounding the site are a mix of undeveloped, residential, and commercial properties. The site is characterized as gently sloping to the north and is vegetated with predominately native grasses and scattered hardwoods. Site elevation ranges from about 760 to 750 feet above mean sea level.

The surficial geologic unit present at the site has been identified as the Buda Formation and Quaternary alluvium. Exhibit 2 (attached) is a geologic map of the site. The site is located in both the recharge zone and the transition zone of the Edwards aquifer and the recharge zone boundary just crosses the far northern edge of the site (see Exhibit 1). The Buda Formation overlies the Edwards Group and is part of the confining unit of the Edwards aquifer. The Buda consists of tan to brown, very hard, medium bedded, coarse grained, crystalline limestone. The formation is approximately 25 feet thick in the area. The Quaternary alluvium overlies the Buda and consists of a typically coarsening downward sequence of clays/silts, sands, and cherty gravel and is about 15 feet thick in the site vicinity. Attachment B (attached) is a stratigraphic column prepared for the site. Exposure of these units onsite is obscured by the soil cover and vegetation present. No evidence of any faulting was observed on the site. Additionally, a review of aerial photographs did not reveal any lineations, which typically indicate the presence of faulting. Based on a review of the Geologic Atlas of Texas Austin Sheet, the closest mapped fault is located about 1,500 feet northwest of the site. The fault trends to the northeast and is associated with the Balcones fault zone, which is comprised of normal, high-angle faults, that are generally down-thrown to the southeast. The Balcones fault zone represents the dominant structural trend of the area.

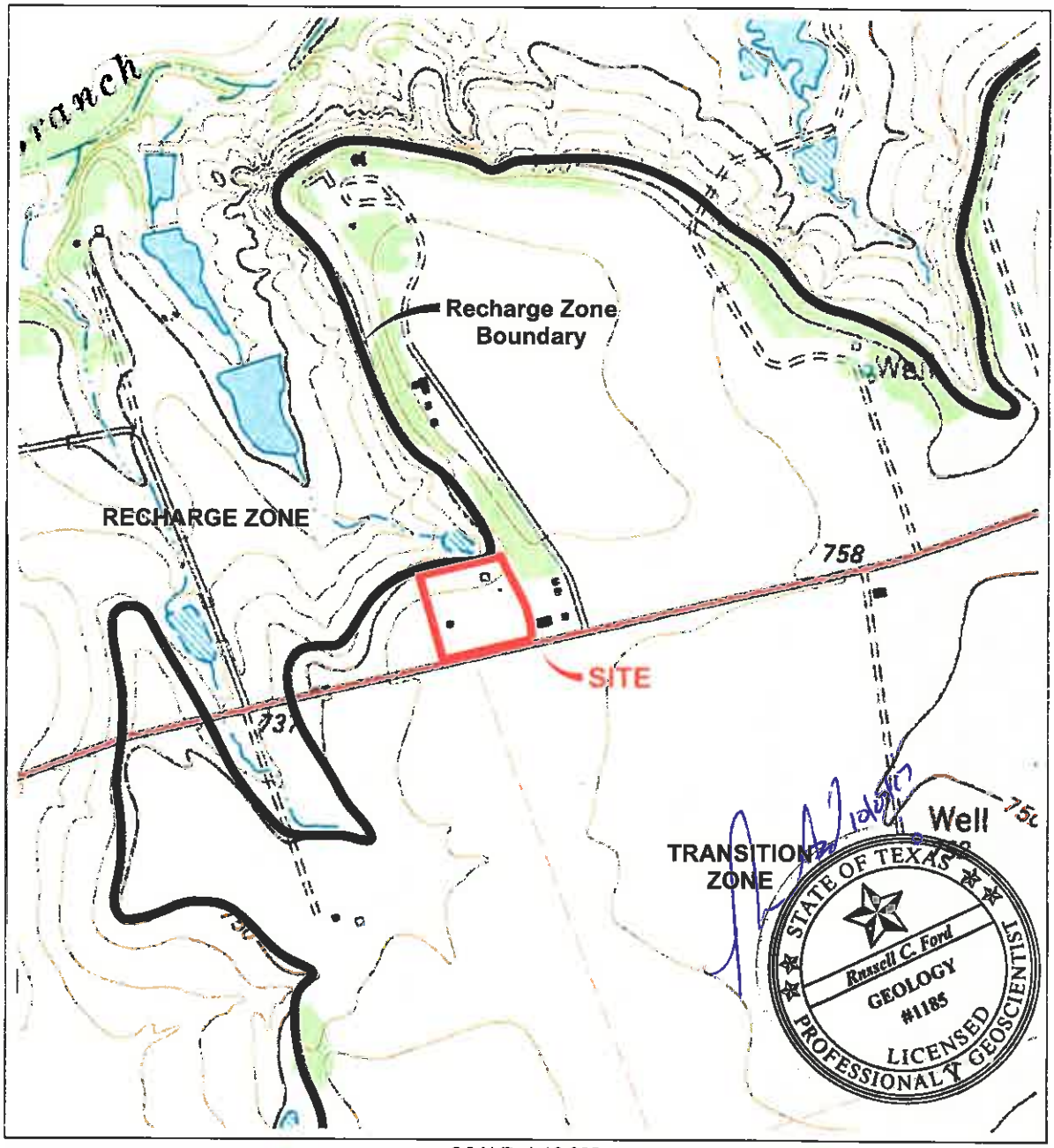
No geologic features were observed on the site. The completed Geologic Assessment form is attached as Attachment A. An existing water well was observed onsite located within a small pump shed. The well is 6-inches in diameter and is equipped with a sanitary well sealing which prevented access into the well. The well is reportedly currently being used for site irrigation. If no future use of the well is planned, it should be properly plugged and abandoned in accordance with applicable regulations. Due to the lack of any significant sensitive recharge features observed on the site and the presence of a relatively impermeable soil cover present, the potential for fluid movement to the Edwards aquifer beneath the site is considered low.

No streams or springs were observed onsite. A review of the site maps contained in the City

of Georgetown Ordinance 2015-14 indicated there are no known springs occupied by the Georgetown Salamander on the site and the nearest known occupied site is located approximately 1 ½ miles northwest of the site (San Gabriel Spring).



UNITED STATES – DEPARTMENT OF THE INTERIOR – GEOLOGICAL SURVEY



SCALE 1:12,000

.5 .25 0 KILOMETERS .5 1

500 0 METERS 500 1000

.5 .25 0 .5

MILES

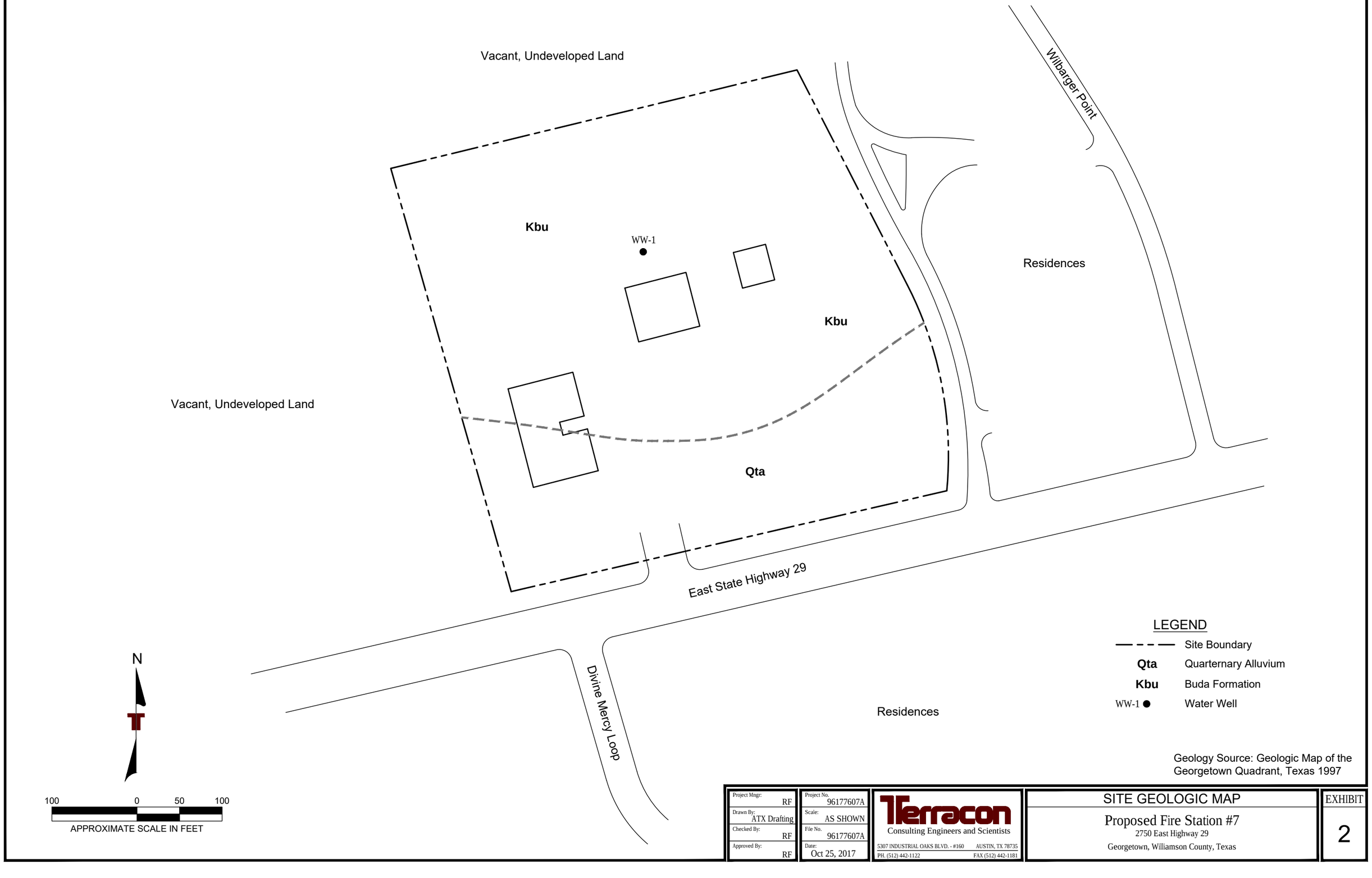
500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

Georgetown, Texas
30097-F6-TF-024
1982
7.5 MINUTE SERIES (TOPOGRAPHIC)

Project Mngr: RF	Project No.: 96177607A	Terracon Consulting Engineers and Scientists	TOPOGRAPHIC MAP	EXHIBIT
Drawn By: ATX Drafting	Scale: AS SHOWN	5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735	Proposed Fire Station #7	1
Checked By: RF	File No.: 96177607A	PH. (512) 442-1122 FAX (512) 442-1181	2750 East Highway 29	
Approved By: RF	Date: Oct 25, 2017		Georgetown, Williamson County, Texas	



Project Mngr: RF	Project No. 96177607A	Terracon Consulting Engineers and Scientists	SITE GEOLOGIC MAP
Drawn By: ATX Drafting	Scale: AS SHOWN	5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735	Proposed Fire Station #7
Checked By: RF	File No. 96177607A	PH. (512) 442-1122 FAX (512) 442-1181	2750 East Highway 29
Approved By: RF	Date: Oct 25, 2017		Georgetown, Williamson County, Texas

EXHIBIT 2

Project Mngr:	AS
Drawn By:	Terracon
Checked By:	CG
Approved By:	AS

Project No:	96177607B
Scale:	AS SHOWN
File No.:	96177607B
Date:	Oct 10, 2017

Terracon
Consulting Engineers & Scientists
5307 INDUSTRIAL OAKS BLVD. - #160 AUSTIN, TX 78735
PH. (512) 442-1122 FAX. (512) 442-1181

USDA Web Soil Survey

Proposed Fire Station #7

East University Avenue, W of NE/SE Inner Loop
Georgetown, Williamson County, Texas

EXHIBIT

3

October 30, 2017

City of Georgetown
809 MLK, Jr. Street
Georgetown, Texas 78626
Attn: Eric Johnson, CIP Manager

Subject: **REPORT OF ASBESTOS SURVEY**
Ralph Anderson Automotive
2703 East State Highway 29
Georgetown, Texas 78626
ACE Project #A17-890

Asbestos Consulting and Environmental (ACE) has completed a survey to identify asbestos-containing materials for the scheduled demolition project at Ralph Anderson Automotive, located at 2703 East State Highway 29, in Georgetown, Texas 78626.

This building survey, sampling, and laboratory analysis was performed in compliance with the Texas Asbestos Health Protection/National Emission Standards for Hazardous Air Pollutants (NESHAP) Rules enforced by the Texas Department of State Health Services (TDSHS) which requires that asbestos-containing building materials be identified and appropriately abated prior to renovation or demolition activities. The field survey and material sampling was performed on October 24, 2017 by Mr. Chris Mayer who is licensed by TDSHS to perform surveys and sampling to identify asbestos.

Eight areas of homogeneous material were suspected to contain asbestos and a total of 16 samples were obtained from these suspect material areas. See the attached table for a complete listing of samples obtained during this survey. NOTE: Suspect materials were not identified at the metal shed.

All samples were collected by removing a small amount of suspect material and placing it in a zip-type plastic bag for shipment to the laboratory. Samples were shipped to Apex Precision Analytical Services, Inc. (APASI) in Friendswood, Texas for microscopic analysis to identify asbestos content using Polarized Light Microscopy (PLM) coupled with dispersion staining as outlined in the Environmental Protection Agency's method EPA 600/R-93/116. APASI is licensed by TDSHS to perform laboratory analysis for bulk samples obtained from *public buildings* in Texas and is accredited by the National Voluntary Laboratory Accreditation Program.

Asbestos Consulting and Environmental
TDSHS Licensed Asbestos Consultant Agency No. 100465
4411 Spicewood Springs Road, Suite #402, Austin, Texas 78759
Phone: (512) 346-7303 Fax: (899) 599-9029
cmayer1@austin.rr.com

Sheet vinyl samples were analyzed and found to contain over 1% asbestos (asbestos-containing material or ACM). A description of ACM observed is provided below:

Sheet Vinyl-RA Automotive Office
Sheet vinyl samples collected from Ralph Anderson Automotive Office were identified as ACM. This material is under non-asbestos floor tile and was only observed at the office. There was approximately 90 square feet of sheet vinyl observed at the office.
This material was observed in good condition.

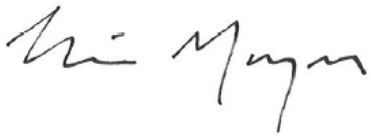
According to the regulations:

- ACM is to be properly abated from a *public building* (as defined by the TDSHS) prior to demolition.
- Occupational Safety and Health Administration (OSHA) regulations apply to all workers exposed to asbestos.
- Project design will not be required but project oversight (including air monitoring and visual inspections) will be required.
- All asbestos removal in Texas should be notified to the state, conducted under properly controlled conditions, and performed by specially trained workers under a licensed asbestos abatement contractor. Texas Asbestos Health Protection rules regarding abatement operations will apply.
- Owner must inform all maintenance, custodial, and renovation/demolition workers of presence and location of ACM.
- New construction materials must not contain asbestos.

This report may be used as proof for permitting purposes that an asbestos investigation has been performed. A copy of this investigation report may be required to be available onsite during demolition activities.

ACE appreciates the opportunity to be of service to City of Georgetown. Please contact me if you have any questions.

Sincerely,
Asbestos Consulting and Environmental



Chris Mayer
Owner

Attachments: List of Materials Sampled
Copy of ACE & Lab Licenses
Laboratory Analysis Reports issued by Apex Precision Analytical Services

LIST OF MATERIALS SAMPLED

Sample ID	Material/Description	Location	Asbestos Content (%)*
01B/C	12" floor tile with yellow mastic-white	Office	ND
02B/C	Sheet vinyl under #01	Office	60
03B/C	Ceiling tile	Office	ND
04B/C	Drywall	Restroom	ND
05	Caulk-white. brittle	Exterior-south side	ND
06	Caulk-gray	Exterior-at office	ND
07	Roof shingle-upper, gray/orange	Exterior-Compressor shack	ND
08	Roof shingle-lower, black/white	Exterior-Compressor shack	ND

ND = No asbestos detected
B/C = Three samples collected
Note: ACM = >1% asbestos content in any sample layer.

Texas Department of State Health Services

Asbestos Individual Consultant

CHRIS H MAYER

License No. 105536

Control No. 97235

Expiration Date: 8/9/2019

TEXAS DEPARTMENT OF STATE HEALTH SERVICES

CHRIS MAYER DBA
ASBESTOS CONSULTING AND ENVIRONMENTAL

is certified to perform as a

Asbestos Consultant Agency

in the State of Texas within the purview of Texas Occupations Code, chapter 1954, so long as this license is not suspended or revoked and is renewed according to the rules adopted by the Texas Board of Health.

JOHN HELLERSTEDT, M.D.
COMMISSIONER OF HEALTH

License Number: 100465

Control Number: 96972

Expiration Date: 1/19/2019

(Void After Expiration Date)

VOID IF ALTERED NON-TRANSFERABLE

TEXAS DEPARTMENT OF STATE HEALTH SERVICES

APEX PRECISION ANALYTICAL SERVICES INC

is certified to perform as a

Asbestos Laboratory
PCM, PLM

in the State of Texas within the purview of Texas Occupations Code, chapter 1954, so long as this license is not suspended or revoked and is renewed according to the rules adopted by the Texas Board of Health.

JOHN HELLERSTEDT, M.D.
COMMISSIONER OF HEALTH

License Number: 300312

Control Number: 96111

Expiration Date: 3/29/2018

(Void After Expiration Date)

VOID IF ALTERED NON-TRANSFERABLE

SECTION 00 45 00 - WAGE RATES

PART 1 - GENERAL

A. The Contractor shall utilize current Davis-Bacon Wage Rates for all labor as required on this project.

B. The Contractor shall print and post the current version of the prevailing Davis-Bacon Wage Rate for the county where the project is being constructed:
   1. Wages must be posted in a visible location.
   2. Current Wage Rates may be found at the following website.
      a. http://www.wdol.gov/wdol/scafiles/davisbacon/TX.

PART 2 - products

Not used.

PART 3 - execution

Not used.

END OF SECTION 00 45 00

SECTION 00 45 00 - REPRESENTATIONS AND CERTIFICATIONS

PART 1 - GENERAL

A. The Contractor shall show that he has experience with similar projects by submitting with the proposal a completed Proposal Questionaire that is bound into the Project Manual.

B. The Contractor shall complete and submit the following forms which are bound into this project manual:

1. State Reciprocal/Non-Collusion Affidavit.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 00 45 00

NON-COLLUSION AFFIDAVIT

STATE OF TEXAS §
§
COUNTY OF WILLIAMSON §

By the signature below, the signatory for the bidder certifies that neither he nor the firm, corporation, partnership or institution represented by the signatory or anyone acting for the firm bidding this project has violated the antitrust laws of this State, codified at Section 15.01, *et seq.*, Texas Business and Commerce Code, or the Federal antitrust laws, nor communicated directly or indirectly the bid made to any competitor or any other person engaged in the same line of business, nor has the signatory or anyone acting for the firm, corporation or institution submitting a bid committed any other act of collusion related to the development and submission of this bid proposal.

Signature: _____

Printed Name: _____

Title: _____

Company: _____

Date: _____

SUBSCRIBED and sworn to before me the undersigned authority by _____ the _____ of, _____on behalf of said bidder.

_____
Notary Public in and for the
State of Texas

My commission expires: _____

SECTION 00 06 00 - BONDS AND INSURANCE

PART 1 - GENERAL

A. Bonds

The project work shall include a 100% Performance Bond and Payment Bonds, as well as a 100% Maintenance Bond for a period of two (2) years from the Substantial Completion date. Copies of bond forms are bound into the Project Manual.

The Owner will require the bonds, within 10 days after the execution of the contract, and prior to any Work being performed in connection with the project. Each bond shall be in the amount of 100% of the contract amount, on forms supplied or approved by Owner, and shall be issued by a corporate surety authorized to do business in the State of Texas and listed on the U. S. Treasury list of acceptable sureties. All bonds must comply with Chapter 2253 of the Texas Government Code, including the requirement that such bonds must be executed by a corporate surety in accordance with Article 7.19-1 of the Texas Insurance Code. All bonds must be accompanied by a bond power of attorney.

B. Insurance

The project work shall include insurance for the duration of the project as described in the attached Exhibit A Insurance Requirements: Professional Services Projects Involving Construction.

C. Copies of the required certificates for insurance and bonds will be provided to the Owner and Architect

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 00 06 00

BID BOND

STATE OF TEXAS '

KNOW ALL MEN BY THESE PRESENTS:

COUNTY OF WILLIAMSON'

That we, _____ as Principal, and _____ as Surety, are hereby held and firmly bound unto the City of Georgetown in the penal sum of: _____ Dollars $_____ OR 5% of the bid, for the payment whereof, the said Principal and Surety bind themselves, their heirs, executors, administrators and successors, jointly and severally firmly by these presents.

The conditions of this obligation are such that, whereas the Principal has submitted a bid to the City of Georgetown for the project named:

_____

_____

Now, Therefore, if the Obligee shall accept the bid of the Principal and the Principal shall enter into a Contract with the Obligee in accordance with the terms of such bid, and give such bonds as may be specified in the bidding or Contract Documents with good and sufficient surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such Contract and give such bond or bonds, if Principal shall pay to the Obligee the difference not to exceed the penalty hereof between the amount specified in said bid and such larger amount for which the Obligee may in good faith contract with another party to perform the Work covered by said bid, then this obligation shall be hull and void, otherwise to remain in full force and effect.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals this _____ day of _____, _____, the name and corporate seal of each corporate party being hereto affixed, and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

_____, Principal (PRINCIPAL'S SEAL if a corporation)

By: _____
Title: _____

_____, Surety (SURETY'S SEAL)

By: _____
Attorney-in-Fact

PERFORMANCE BOND

STATE OF TEXAS '

KNOW ALL MEN BY THESE PRESENTS:

COUNTY OF _____ '

That we, _____ as Principal, and _____ as Surety, are hereby held and firmly bound unto the City of Georgetown in the penal sum of: _____ Dollars $_____ for the payment whereof, the said Principal and Surety bind themselves, their heirs, executors, administrators and successors, jointly and severally firmly by these presents.

The conditions of this obligation are such that, whereas the Principal entered into a certain contract, hereto attached and made a part hereof, with the City of Georgetown, dated _____ for the _____ _____ _____

Now, if the Principal shall faithfully perform the contract in accordance with the plans, specifications and contract documents, and shall fully indemnify and save harmless the City of Georgetown from all costs of damage which the City of Georgetown may suffer by reason of the Principal's default or failure to perform and shall fully reimburse and repay the City of Georgetown all outlay and expense which the City of Georgetown may incur in making good any such default, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

In the event Principal is in default under the contract as defined herein, Surety will within fifteen (15) days of determination of such default take over and assume completion of such contract and become entitled to the payment of the balance of the contract price, or the Surety shall make other arrangements satisfactory with the obligee for the completion of the defaulted work but in no event shall the Surety's liability exceed the penalty of this bond.

The Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to the work to be performed thereunder or the specifications accompanying the same shall in any wise affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the work or to the specifications.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals this _____ day of _____, _____, the name and corporate seal of each corporate party being hereto affixed, and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

_____, Principal (PRINCIPAL'S SEAL if a corporation)

By: _____
Title: _____

_____, Surety (SURETY'S SEAL)

By: _____
Attorney-in-Fact

PAYMENT BOND

STATE OF TEXAS '

KNOW ALL MEN BY THESE PRESENTS:

COUNTY OF _____ '

That we, _____ as Principal, and _____ as Surety, are hereby held and firmly bound unto the City of Georgetown in the penal sum of: _____ Dollars $_____ for the payment whereof, the said Principal and Surety bind themselves, their heirs, executors, administrators and successors, jointly and severally firmly by these presents.

The conditions of this obligation are such that, whereas the Principal entered into a certain contract, hereto attached and made a part hereof, with the City of Georgetown, dated _____ for the _____ _____ _____

Now, if the Principal shall promptly make payments to all claimants as defined in Texas Government Code, Chapter 2253, supplying labor and materials in the prosecution of the work provided for in said contract, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

This bond is made and entered into solely for the protection of all claimants supplying labor and material in the prosecution of the work provided for in said contract, and all such claimants shall have a direct right of action under the bond as provided in Texas Government Code, Chapter 2253.

The Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to the work to be performed thereunder or the specifications accompanying the same shall in any wise affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract or to the work or to the specifications.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals this _____ day of _____, _____, the name and corporate seal of each corporate party being hereto affixed, and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

_____, Principal (PRINCIPAL'S SEAL if a corporation)

By: _____
Title: _____

_____, Surety (SURETY'S SEAL)

By: _____
Attorney-in-Fact

SECTION 008200 - SPECIAL CONDITIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 GENERAL

A. Construct and complete the designated project including certain site improvements and appurtenance indicated, excepting only those items specifically noted as not in contract (N.I.C.) or by Owner's Contractor.

B. All major work including utilities will be let under a single prime contract.

C. Confirm operations at site to areas permitted by law, ordinances, permits, or Contract Documents.
   1. Do not unreasonably encumber site with materials or equipment.
   2. Do not load structures with weights that will endanger structure.
   3. Assume full responsibility for protection and safekeeping of products stored on premises.
   4. Obtain and pay for use of additional storage or areas needed for operations.

1.03 INTRODUCTION TO SECTION FORMAT

A. Description:
   1. Extent of work required includes, but is not limited to, the scope indicated.
   2. Provide all items, articles, materials, operations and methods listed, mentioned, or scheduled on the Drawings or in the Specifications and related Construction Documents, including all labor, materials, equipment, and incidents necessary and required for their completion, as reasonably implied.

B. Related Work Specified Elsewhere:
   1. All contractual and related documents, and applicable portions of Division 01 General Requirements, are part of all Specification Trade Sections.
   2. Refer to applicable sections for other related work.

C. References:
   1. Obtain and conform to manufacturer's directions for installation, connection and/or erection of all manufactured articles, materials and equipment.
   2. Conform to applicable portion of listed reference standards as minimum requirements.

3. References to standard specifications shall mean to the latest edition of such specifications, including all revisions thereto.
4. The applicable issues of the publications listed, but referred to thereafter by basic designation only, form a part of the specifications to the extent indicated by reference thereto.

1.04 CORRELATION OF DOCUMENTS

A. Civil, Structural, Mechanical, and Electrical Drawings are supplementary to the Architectural Drawings.

B. Architectural Drawings are supplementary to Architectural Specifications.

C. Refer to Architectural Drawings for verification of locations, sizes and dimensions.

D. Arrange any necessary changes, furnishing fittings, and accessories as required to meet architectural conditions.

E. Notify Architect immediately of any discrepancy, error or doubtful instructions as provided in the General Conditions.

1.05 COORDINATION WITH OWNER-FURNISHED ITEMS

A. It is understood that operations necessary to perform the Work required may cause damage to items not directly related to the specific Work.

B. The Contractor is advised to take any action necessary to avoid such damage where possible.

C. Damaged items are to be replaced or repaired to the original existing condition prior to commencement of this Work.

1.06 EROSION CONTROL

A. A Storm Water Pollution Prevention Plan (SWP3), or Erosion Control Plan (ECP) has been prepared for the project and is incorporated into this proposal package. The Contractor and the Owner will be co-operators for the site as defined in the National Pollution Discharge Elimination System (NPDES) General Permit issued for storm water discharges from construction sites. Both the Contractor and the Owner will submit a Notice of Intent (NOI) as co-permitees to discharge storm water from sites that disturb more than 5 acres in compliance with the General Permit.

B. All additional contractors and/or subcontractors whose activities impact the (SWP3) shall sign a certification stating that they understand their responsibilities under the Plan.

1.07 PHOTOGRAPHIC DOCUMENTS

A. Provide digital photographs to document the existing conditions of the proposed work areas prior to beginning work.

B. Maintain electronic copies of all photographs at the site during the Work and deliver to the Owner at completion of the Work.

C. Label photographs describing location and "before" or "after".

1.08 CONSTRUCTION CAMERAS

A. Provide and maintain at site (2) two construction cameras installed at the front exterior and rear exterior of the location to record and provide web access to construction activities.

B. Manufacturer: iBEAM Construction Cameras, Model: iBEAM Time-Lapse Pro, or approved equal.

1.09 NOTICE REGARDING ASBESTOS

A. It is the intent of these Contract Documents that all materials to be incorporated into the work be free of asbestos in any form. The Contractor is to notify Architect immediately when he/she becomes aware or suspects that any material contains asbestos. The Owner will require that the Contractor certify that asbestos has not been incorporated into the project.

END OF SECTION 00 08 20

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Contractor's Duties.
   4. Procedures for requesting additional time due to Weather Delays.
   5. Work by Owner.
   6. Owner-furnished products.
   7. Access to site.
   8. Coordination with occupants.
   9. Work restrictions.
   10. Specification and drawing conventions.

B. Related Requirements:
   1. Division 01 Section - Temporary Facilities and Controls for limitations and procedures governing temporary use of Owner's facilities.

1.03 PROJECT INFORMATION

A. Project Identification: Georgetown Fire Station No. 6. BRW Project No. 217079.00
   1. Project Location: 6700 R.M. 2338, Georgetown, TX 78633.

B. Owner: City of Georgetown.
   1. Owner's Representative: Eric Johnson, City Manager, Telephone: (512) 819-3145 Email: eric.johnson@georgetown.org

C. Architect: Brown Reynolds Watford Architects, Inc., 2700 Earl Rudder Freeway South, Suite 4000, College Station, Texas 77845 Telephone: (979) 694-1791 Fax: (979) 842-8293

D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:
   1. Civil Engineer: Strand Associates, Inc., 203 S Jackson St., Brenham, TX 77833.
   2. Professional Sanitarian: Brandon L. Couch, R.S., 2314 Rock Ledge Dr., Georgetown, TX 78626.
   3. Structural Engineer: Gessner Engineering, 2501 Ashford Drive, Suite 102, College Station, Texas 77840.
   4. MEP Engineering: Dawson Van Orden, Inc., 1250 Wood Branch Park Drive, Suite 210, Houston, TX 77079.

1.04 CONTRACTOR'S DUTIES

A. Furnish & provide for proper execution and completion of work as required by the Contract Documents all:
   1. Labor, materials and equipment.
   2. Tools, construction equipment and machinery.
   3. Water, heat and utilities required for construction.

4. Other facilities and services necessary for proper execution and completion of the work.

B. Attain and pay for all required permits, licenses, and government fees as required by the authority having jurisdiction.
   1. Unless specifically indicated otherwise, Contractor is responsible to hire and pay for all third party reviews and inspections required by authorities having jurisdiction.
      a. Architect will retain and Owner will pay for handicap accessibility inspection required by TDLR. Coordinate scheduling with Architect to coincide with or to follow after substantial completion.

C. Give required notices.

D. Comply with codes, ordinances, rules, regulations, orders and other legal requirements of public authorities which bear on performance of work.

E. Promptly submit written notice to Architect of observed variance of Contract Documents from legal requirements. It is not Contractor's responsibility to make certain that drawings and specifications comply with codes and regulations.

F. Contractor shall verify all conditions at the site and dimensions in the field prior to starting work. Architect shall be notified in writing of any discrepancies found.

G. The Drawing and Specifications represent the work to be completed not the method of construction. However, the Contractor shall perform all demolition and remedial work in a sequence to where any interruption of the operation of the facilities or utility service occurs at an absolute minimum.

H. Contractor shall use every precaution to prevent damage to roads, landscape, adjacent property, building and utilities above and below ground that are adjacent to or included in the area under contract. The Contractor shall repair and replace, at his expense, any material or building affected, damaged or destroyed because of his operations or work.

I. Safety Requirements: The CONTRACTOR has full responsibility for the safety of workers and for all damages to personal property caused by its operations. The CONTRACTOR is responsible for following all Federal, State, and Local Regulations and Guidelines with regards to worker and public safety. Unless otherwise indicated on the proposal, the necessary tools, equipment, procedures, etc. for following the appropriate regulations and guidelines will be considered subsidiary to other proposal items.

1.05 WEATHER DAYS

A. The Contractor may be granted an extension of time because of abnormal inclement weather conditions. Contractor shall submit reports on monthly intervals indicating the rainfall and temperature on inclement weather days to document for each month the days in excess of normal inclement weather conditions that may contribute to future time extension requests.
   1. Provide reports each month whether or not Contractor believes at that time that time extension will be necessary. In months not exceeding normal inclement weather days and for which additional time will not be requested, reports need not be provided.
   2. Available float shall be used before any request is made for time extension due to inclement weather.

B. For the purpose of this contract, "abnormal inclement weather" will be interpreted as those days in excess of the number of days shown in columns B and D in the below PRECIPITATION / TEMPERATURE chart for exterior critical path activities. Drying days shall also be interpreted as "abnormal inclement weather" days.

C. Weather Conditions: The information in the following tables was compiled from the records of the National Weather Service for the Georgetown area (See web site: http://w2.weather.gov/climate/xmacis.php?wfo=bro).

PRECIPITATION / TEMPERATURE

COLUMN	A	B	C	D
Month	Normal (Inches)	Average Days w/ 0.1" or More Rain	Normal Temperature (Degrees F.)	Average Days 32 Degrees F. or Below
Jan.	2.20	1	46.6	18
Feb.	2.31	3	52.1	3
Mar.	2.78	2	59.2	0
Apr.	2.27	4	67.3	0
May	4.05	3	75.2	0
Jun.	4.63	3	81.0	0
Jul.	2.44	3	83.4	0
Aug.	2.03	4	83.7	0
Sep.	2.54	3	77.8	0
Oct.	4.24	3	69.0	1
Nov.	2.94	2	58.4	1
Dec.	2.21	4	50.4	10

D. All claims for additional time shall be limited to time extensions only. Claims for additional costs due to time extensions shall not be considered.

1.06 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:
   1. Work of the project is for all labor, supervision, materials, services and equipment required in conjunction with all work to construct a new 1.5 story Fire Station of approximately 11,125 square feet. The occupancy classification is mixed occupancy with Storage (S-1) and Business (B). The type of construction is Type V-B (fully sprinklered). Fire Station will include a public entry, treatment room, meeting room, offices, day room, kitchen/dining, sleeping rooms, workout room, 3 pull-through apparatus bays, and apparatus bay support spaces. Above the living quarters will include storage, elec./comm. room, and mechanical equipment room. The exterior will be building stone veneer and fiber-reinforced cementitious lap siding over wood sheathing. The foundation will be a stiffened slab on grade. The structural system will be wood stud framing with pre-engineered wood floor and roof trusses, with steel columns and beams primarily around apparatus bays doors and in the Station tower. Site work includes clearing, grading, utilities to building, OSSF, LP tank, concrete paving, landscaping, concrete plaza, and irrigation.

B. Type of Contract:
   1. Project will be constructed under a single prime contract.

1.07 WORK BY OWNER

A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

B. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.

1. Telecommunications wiring and equipment installation, including voice, data, and cable TV.
2. Audio/Visual wiring and equipment installation.
3. Security System and Security Camera System (CCTV) wiring and equipment installation.
4. Station Altering System

C. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory work under this Contract.
1. Furniture, fixturing and equipment installation.

1.08 OWNER-FURNISHED PRODUCTS

A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.

B. Owner-Provided/Contract Install Products:
1. Gear Extractor, Gear Dryer, Clothes Washer, Clothes Dryer, Commercial Ice Maker, SCBA Compressor, Air Compressor, Refrigerator w/ Ice Maker

C. Owner-Provided Products:
1. Microwaves, Coffee Maker, Mini-Fridge

1.09 ACCESS TO SITE

A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

1.10 COORDINATION WITH OCCUPANTS

A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.11 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.
1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
2. Comply with work hour and noise restriction requirements of local authorities, if such exist.

1.12 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
   2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
   1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
   2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
   3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS
Not Used.

PART 3 - EXECUTION
Not Used.

END OF SECTION 01 10 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.03 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
   3. Alternate Bids shall include all overhead and profit applicable to that portion of the work.
   4. The description below for each Alternate Bid is recognized to be incomplete and abbreviated, but implies that each change must be complete for the scope of work affected. The descriptions are primarily scope definitions, and do not necessarily detail the full range of materials and processes needed to complete the work as required. Refer to applicable Specification Sections, and to applicable drawings, for the specific requirements of the work, regardless of whether references are so noted in the description of each Alternate. Coordinate related work and modify surrounding work as required to properly integrate with the work of each Alternate. Any change of details, construction, etc., as required to accommodate the Alternate shall be the responsibility of the Contractor and shall be included in his Alternate Bid Price.
   5. Where methods of construction, materials, finishes, or details of installation, required by the various Alternate Bids, differ from the requirements shown on drawings or specified for corresponding items, the Alternate construction, materials, etc., will be subject to approval by the Architect.
   6. Approval of the Alternate makes all requirements of scope, performance, submissions, service and guarantee binding as any other material name appearing in the Specifications for the Base Bid. All necessary changes in building design or construction to accommodate the alternate materials shall be the sole responsibility of the Contractor without extra cost to the Owner.

1.04 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

2. Prior to installation of the Alternate items, verify that all surfaces have been modified as necessary to accept the installation and that the item or items may be installed in complete accordance with their manufacturer's current recommendations. Notify the Architect of any discrepancies before proceeding.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 SCHEDULE OF ALTERNATES

A. Add Alternate No. 1: Provide Additional Irrigation Coverage.
   1. Refer to Sheet L1.3 and Specification Section 32 84 00 Planting Irrigation.

END OF SECTION 01 23 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Division 01 Section - Allowances for products selected under an allowance.
   2. Division 01 Section - Alternates for products selected under an alternate.
   3. Division 01 Section - Product Requirements for requirements for submitting comparable product submittals for products by listed manufacturers.
   4. Divisions 02 through 33 Sections for specific requirements and limitations for substitutions.

1.03 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.04 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use form acceptable to Architect.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
      b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.05 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.06 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Substitution request is fully documented and properly submitted.

c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Architect will consider requests for substitution if received within 30 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Architect.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Substitution request is fully documented and properly submitted.
e. Requested substitution will not adversely affect Contractor's construction schedule.
f. Requested substitution has received necessary approvals of authorities having jurisdiction.
g. Requested substitution is compatible with other portions of the Work.
h. Requested substitution has been coordinated with other portions of the Work.
i. Requested substitution provides specified warranty.
j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION

Not Used.

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:
   1. Division 01 Section - Substitution Procedures for administrative procedures for handling requests for substitutions made after the Contract award.

1.03 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 (or similar), "Architect's Supplemental Instructions."

1.04 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
      e. Quotation Form: Use AIA Document G709 (or similar) for Proposal Requests.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 01 Section "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use AIA Document G709 (or similar) for Proposal Requests.

1.05 ADMINISTRATIVE CHANGE ORDERS

A. Allowance Adjustment: See Division 01 Section "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.

1.06 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.07 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
   1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:
   1. Division 01 Section - Allowances for procedural requirements governing the handling and processing of allowances.
   2. Division 01 Section - Contract Modification Procedures for administrative procedures for handling changes to the Contract.
   3. Division 01 Section - Construction Progress Documentation for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.03 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.04 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
   1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with continuation sheets.
      b. Submittal schedule.
      c. Items required to be indicated as separate activities in Contractor's construction schedule.
   2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
   1. Identification: Include the following Project identification on the schedule of values:
      a. Project name and location.
      b. Name of Architect.
      c. Architect's project number.
      d. Contractor's name and address.
      e. Date of submittal.
   2. Arrange schedule of values consistent with format of AIA Document G703.
   3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
    a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
6. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
9. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.05 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: Submit Application for Payment to Architect by the 1st day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
    1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.

C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment, or similar forms acceptable to Architect and Owner Submit forms for approval with initial submittal of schedule of values.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
    1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
    2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
    3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
    4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:
    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
2. If approved by Owner, submit electronic transmission of Pay Application, in lieu of paper copies.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Submittal schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. List of Contractor's principal consultants.
8. Copies of building permits.
9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
10. Initial progress report.
11. Report of preconstruction conference.
12. Certificates of insurance and insurance policies.
13. Performance and payment bonds.
14. Data needed to acquire Owner's insurance.

I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. Evidence that claims have been settled.
7. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
8. Final liquidated damages settlement statement.

PART 2 - PRODUCTS
Not Used.

PART 3 - EXECUTION
Not Used.

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General coordination procedures.
   2. Conservation.
   3. Correlation of Documents.
   4. Coordination drawings.
   5. Requests for Information (RFIs).
   6. Project Web site.
   7. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:
   1. Division 01 Section - Construction Progress Documentation for preparing and submitting Contractor's construction schedule.
   2. Division 01 Section - Execution for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   3. Division 01 Section - Closeout Procedures for coordinating closeout of the Contract.

1.03 DEFINITIONS

A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.04 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, and telephone number of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
   1. Post copies of list in project meeting room and in temporary field office. Keep list current at all times.

1.05 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
   1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.06 CORRELATION OF DOCUMENTS

A. Any discrepancy in the documents shall be interpreted to include the most restrictive or costly solution. In case of discrepancy either in figures or Drawings or Specifications, the matter must be promptly submitted by the Contractor to the Architect, who will promptly make a determination in writing. Any adjustment by the Contractor without such a determination by the Architect will be at the Contractor's own risk and expense. The Architect will furnish, as necessary, additional detailed Drawings and information for clarification.

B. If a document discrepancy is identified prior to bidding, the Architect is to be notified so a written clarification may be issued.

C. Any survey drawing documents included herein are for convenience of the Contractor and Owner. The Architect assumes no responsibility as to their completeness or accuracy.

D. Anything mentioned in the Specifications and not shown on the Drawings, or shown on the Drawings and not mentioned in the Specifications, is of like effect as if shown or mentioned in both.

E. On any of the Drawings in which a portion of the work is detailed or drawn out and the remainder is shown in outline, the parts detailed or drawn out will apply also to all other like portions of the work.

F. When the word "similar" appears on Drawings, it has a general meaning and must not be interpreted as meaning identical. All details must be worked out in relation to their location and connection with other parts of the work.

G. Refer to Architectural Drawings for verification of locations, sizes and dimensions.

1.07 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
    b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
    c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
    e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
    f. Indicate required installation sequences.
    g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Refer to Division 23 Section - Basic Mechanical Materials and Methods and Division 26 Section - Basic Electrical Materials and Methods for specific Coordination Drawing requirements for mechanical and electrical installations.
7. Mechanical and Plumbing Work: Work to be shown shall include, but not be limited to the following:
    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.
8. Electrical Work: Work to be shown shall include, but not be limited to the following:
    a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.
9. Fire-Protection System: Work to be shown shall include, but not be limited to the following:
    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
10. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
11. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Division 01 Section - Submittal Procedures.
12. Staff Names: Submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site with the bid proposal. Within 15 days of starting construction operations, identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
13. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone

1.08 REQUESTS FOR INFORMATION (RFI'S)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
    1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
    2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
    1. Project name.
    2. Project number.

3. Date.
4. Name of Contractor.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716, Form bound in Project Manual, or Software-generated form with substantially the same content as indicated above, acceptable to Architect.
   1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section - Contract Modification Procedures.
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log monthly. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect.
   4. RFI number including RFIs that were returned without action or withdrawn.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's response was received.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.09 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
   1. Conduct the conference to review responsibilities and personnel assignments.
   2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   3. Agenda: Discuss items of significance that could affect progress, including the following:
      a. Tentative construction schedule.
      b. Critical work sequencing and long-lead items.
      c. Designation of key personnel and their duties.
      d. Lines of communications.
      e. Procedures for processing field decisions and Change Orders.
      f. Procedures for RFIs.
      g. Procedures for testing and inspecting.
      h. Procedures for processing Applications for Payment.
      i. Distribution of the Contract Documents.
      j. Submittal procedures.
      k. Preparation of record documents.
      l. Work restrictions.
      m. Working hours.
      n. Owner's occupancy requirements.
      o. Responsibility for temporary facilities and controls.
      p. Procedures for moisture and mold control.
      q. Procedures for disruptions and shutdowns.
      r. Construction waste management and recycling.
      s. Parking availability.
      t. Office, work, and storage areas.
      u. Equipment deliveries and priorities.
      v. First aid.
      w. Security.
      x. Progress cleaning.
   4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and Owner's Commissioning Authority of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.
    f. Deliveries.
    g. Submittals.
    h. Review of mockups.
    i. Possible conflicts.
    j. Compatibility requirements.
    k. Time schedules.
    l. Weather limitations.
    m. Manufacturer's written instructions.
    n. Warranty requirements.
    o. Compatibility of materials.
    p. Acceptability of substrates.
    q. Temporary facilities and controls.
    r. Space and access limitations.
    s. Regulations of authorities having jurisdiction.
    t. Testing and inspecting requirements.
    u. Installation procedures.
    v. Coordination with other work.
    w. Required performance results.
    x. Protection of adjacent work.
    y. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 30 days prior to the scheduled date of Substantial Completion.
    1. Conduct the conference to review requirements and responsibilities related to Project closeout.
    2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
    3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
        a. Preparation of record documents.

b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures.
j. Coordination of separate contracts.
k. Owner's partial occupancy requirements.
l. Installation of Owner's furniture, fixtures, and equipment.
m. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at monthly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
1) Review schedule for next period.
b. Review present and future needs of each entity present, including the following:
1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Progress cleaning.
10) Quality and work standards.
11) Status of correction of deficient items.
12) Field observations.
13) Safety
14) Work hours
15) Status of RFIs.
16) Status of proposal requests.
17) Pending changes.
18) Status of Change Orders.

19) Pending claims and disputes.
20) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Startup construction schedule.
   2. Contractor's construction schedule.
   3. Submittals schedule
   4. Construction schedule updating reports.
   5. Daily construction reports.
   6. Material location reports.
   7. Site condition reports.
   8. Special reports.
   9. Construction photographs.

B. Related Requirements:
   1. Division 01 Section - Payment Procedures for submitting the Schedule of Values.
   2. Division 01 Section - Project Management and Coordination for submitting and distributing meeting and conference minutes.
   3. Division 01 Section - Submittal Procedures for submitting schedules and reports.
   4. Division 01 Section - Quality Requirements for submitting a schedule of tests and inspections.
   5. Division 01 Section - Closeout Procedures for submitting photographic negatives as Project Record Documents at Project closeout.

1.03 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
   1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.

1.04 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
   1. Working electronic copy of schedule file, where indicated.
   2. PDF electronic file.

B. Startup construction schedule.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

D. Construction Photographs: Submit electronic copies of each photographic view with Application for Payment.

1. Format: jpeg electronic file.
2. Submit a complete set of photographs on CD or USB Drive as a Project Record Document. Identify date photographs were taken.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Architect's final release or approval.

G. Daily Construction Reports: Submit at monthly intervals.

H. Material Location Reports: Submit at monthly intervals.

I. Site Condition Reports: Submit at time of discovery of differing conditions.

J. Special Reports: Submit at time of unusual event.

1.05 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

C. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting.

PART 2 - PRODUCTS

2.01 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.02 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for Notice of Award to date of final completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
   2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
   3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section - Submittal Procedures in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
   4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
   5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
   6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
   1. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
   2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section - Summary. Delivery dates indicated stipulate the earliest possible delivery date.
   3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section - Summary. Delivery dates indicated stipulate the earliest possible delivery date.
   4. Work Restrictions: Show the effect of the following items on the schedule:
      a. Coordination with existing construction.
      b. Uninterruptible services.
      c. Use of premises restrictions.
      d. Seasonal variations.
      e. Environmental control.
   5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
      a. Subcontract awards.
      b. Submittals.
      c. Purchases.
      d. Mockups.
      e. Fabrication.
      f. Sample testing.
      g. Deliveries.
      h. Installation.

i. Tests and inspections.
j. Adjusting.
k. Curing.

6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Temporary enclosure and space conditioning.
   c. Permanent space enclosure.
   d. Completion of mechanical installation.
   e. Completion of electrical installation.
   f. Substantial Completion.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion**.**

E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
   1. Unresolved issues.
   2. Unanswered Requests for Information.
   3. Rejected or unreturned submittals.
   4. Notations on returned submittals.
   5. Pending modifications affecting the Work and Contract Time.

F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.03 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for the Notice of Award. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

2.04 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
   1. List of subcontractors at Project site.
   2. List of separate contractors at Project site.
   3. Approximate count of personnel at Project site.
   4. Equipment at Project site.
   5. Material deliveries.
   6. High and low temperatures and general weather conditions, including presence of rain or snow.
   7. Accidents.
   8. Meetings and significant decisions.

9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

PART 3 - EXECUTION

3.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.
   2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

3.02 CONSTRUCTION PHOTOGRAPHS

A. Format: digital, jpeg.

B. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.

C. Preconstruction Photographs: Before starting construction, take twelve color photographs of Project site and surrounding properties from different vantage points, as directed by Architect. Show existing conditions adjacent to property.

D. Periodic Construction Photographs: Take twelve color photographs monthly, coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.

E. Final Completion Construction Photographs: Take twelve color photographs after date of Substantial Completion for submission as Project Record Documents. Architect will direct photographer for desired vantage points.

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Periodic construction photographs.
   2. Final completion construction photographs.
   3. Web-based construction photographic documentation.

B. Related Requirements:
   1. Division 01 Section - Submittal Procedures for submitting photographic documentation.
   2. Division 01 Section - Closeout Procedures for submitting photographic documentation as project record documents at Project closeout.

1.03 INFORMATIONAL SUBMITTALS

A. Digital Photographs: Submit image files within three days of taking photographs.
   1. Digital Camera: Minimum sensor resolution of 8 megapixels.
   2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph.

1.04 QUALITY ASSURANCE

A. Web-Based Photographic Documentation Service Provider: A firm specializing in providing photographic equipment, Web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project.

1.05 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

2.02 WEB-BASED PHOTOGRAPHIC DOCUMENTATION

A. Project Camera: Provide fixed exterior camera installation, mounted to provide unobstructed view of construction site from locations approved by Architect.
   1. Provide two (2) fixed-location cameras, with the following characteristics:
      a. Static view
      b. Capable of producing minimum 3.0 megapixel pictures.
      c. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.

B. Web-Based Image Access: Password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.

PART 3 - EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
   1. Date and Time: Include date and time in file name for each image.
   2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

C. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.

D. Periodic Construction Photographs: Take 24 photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

E. Final Completion Construction Photographs: Take 24 color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.

3.02 WEB-BASED CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

A. Live Streaming Construction Site Images: Provide Web-accessible image of current site image from fixed location camera(s), updated at 15 minute intervals during daytime operation.

B. Time-Lapse Sequence Construction Site Recordings: Provide video recording from a fixed-location camera to show status of construction and progress.
   1. Frequency: Record one frame of video recording every 15 minutes, from same vantage point each time, to create a time-lapse sequence of construction activities.
   2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.

C. Maintain cameras and Web-based access in good working order according to Web-based construction photographic documentation service provider's written instructions until final completion. Provide for service of cameras and related networking devices and software.

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:
   1. Division 01 Section - Payment Procedures for submitting Applications for Payment and the schedule of values.
   2. Division 01 Section - Project Management and Coordination for submitting Coordination Drawings.
   3. Division 01 Section - Construction Progress Documentation for submitting schedules and reports, including Contractor's construction schedule.
   4. Division 01 Section - Operation and Maintenance Data for submitting operation and maintenance manuals.
   5. Division 01 Section - Project Record Documents for submitting record Drawings, record Specifications, and record Product Data.
   6. Division 01 Section - Closeout Procedures for submitting warranties Project Record Documents and operation and maintenance manuals.

1.03 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.04 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
4. Format: Arrange the following information in a tabular format:
    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for purchasing.
    i. Scheduled dates for installation.
    j. Activity or event number.

1.05 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings may be provided by Architect for Contractor's use in preparing submittals.
    1. Architect may furnish Contractor specifically requested digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.
        a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
        b. Digital Drawing Software Program: The Contract Drawings are available in AutoCad format.
        c. Contractor shall execute a data licensing agreement in the form of an Agreement acceptable to Architect, as a prerequisite for Architect providing electronic files. Architect's consultants may require additional agreements as condition for release of their electronic files.
            1) Contractor shall bind all parties receiving or using these files to the same agreements.
        d. The following digital data files may be furnished for each appropriate discipline:
            1) Site plan.
            2) Architectural floor plans.
            3) Drawings specifically requested by Contractor and agreed to be provided by the Architect and Architect's consultants.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
    1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
    2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
    3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
    1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
    2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
    3. Resubmittal Review: Allow 15 days for review of each resubmittal.
    4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
    5. Concurrent Review of Submittals: Where two or more submittals require concurrent review, Architect retains the right to hold submittals until all submittals required for concurrent review are received. Architect will notify Contractor of necessity for concurrent submittals after a submittal is received in absence of other related submittals required for concurrent review. The date of receipt of the last submittal required for concurrent review will be considered the date for the start of Architect's review time.
        a. Examples of submittals for concurrent review include, but are not limited to: Roofing and related flashing, accessories, and waterproofing installed by roofer; doors, door frames, and hardware submittals; and window or glazing systems and glass.

D. Transmittals for Electronic Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return without review or discard any submittals received from sources other than the Contractor. Package each submittal individually. Do not group different specification sections together in one submittal. Provide transmittal form including the following information:
    1. Submittal number unique identifier, including revision identifier, and with identification of submittal contents as follows:
        a. Submittal number shall use Specification Section number followed by a dash and then a sequential number (e.g., 061000-01). Resubmittals shall include another dash followed by the letter ‘R’ and a sequential number (e.g., 061000-01-R1), or next sequential number.
        b. Name of Specification Section, with brief description of submittal contents for sections requiring multiple submittals.
    2. Overall sequence number each submittal starting with number 1 for the first submittal transmitted to the Architect, 2 for the second and so forth, indicating the chronological submission of each submittal.
    3. Provide means for insertion to permanently record Contractor's review and approval markings. Indicate Contractor's completed review prior to submitting to Architect.
    4. Include the following information for processing and recording:
        a. Project name.
        b. Date of submission to Architect.
        c. Name of Architect.
        d. Name of Contractor.

e. Additionally, indicate names of the following, as applicable, including indication of the entity that prepared each submittal:
   1) Name of subcontractor.
   2) Name of supplier / vendor.
   3) Name of manufacturer.
f. Drawing number and detail references, as appropriate.
g. Location(s) where product is to be installed, as appropriate.
h. Remarks and other necessary identification.
i. Signature of transmitter.

E. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
   1. Number of Copies: Provide paper submittals with a minimum of 2 copies for submittals for Architect's review, with an additional copy for each of Architect's consultants that will also review each submittal. Architect, and each of Architect's consultants involved in review, will retain one copy each for their records, and return additional copies with annotations.
      a. Submit additional copies if Contractor requires more than one paper copy returned for Contractor's use. When shop drawings are required to be annotated by Contractor for as-built conditions and submitted as record drawings, include a copy dedicated for this purpose.
      b. Submit additional copies as required by each other concurrent reviewer, as applicable, in addition to specified number of copies to Architect.
   2. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

F. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
   1. Assemble complete submittal package into a single indexed .pdf format file, or .pdf files within a .zip file where multiple files cannot be avoided, incorporating submittal requirements of a single Specification Section and transmittal form. Name file according to Submittal number and contents identification.
   2. Architect, and Architect's consultants as applicable, will return electronic submittal with annotations containing their comments as applicable.
   3. Architect retains right to require a paper submittal for shop drawings or other complex submittals that may require substantial notation to be marked on submittal sheets or drawings, at Architect's discretion.

G. Options: Circle or highlight options to be provided on product data and specification sheets. Identify options requiring selection by Architect with red colored boxes or text.

H. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

I. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
   1. Note date and content of previous submittal.
   2. Note date and content of revision in label or title block and clearly indicate extent of revision.
   3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

K. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.01 SUBMITTAL PROCEDURES

A. Organization: All required submittals for a specification section must be transmitted together complete as one submittal transmittal. Partial transmittals will not be accepted for review.

B. Contractor's responsibilities:
   1. Contractor shall thoroughly check shop drawings, project data and samples for compliance with Contract Documents and list variances prior to submission.
   2. Contractor represents by approving and submitting Shop Drawings, Product Data and samples that he has or will coordinate and verify dimensions, all materials, field measurements, field construction criteria, catalog numbers and similar data with requirements of work and of Contract Documents prior to submitting.
   3. Submittals shall bear Contractor's stamp and initials certifying that they have been checked. Submittals without stamp & initials shall be returned un-reviewed.
   4. Contractor's responsibility for deviations or errors and omissions in submittals is not relieved by Architect/ Engineer review of submittals, unless Architect/ Engineer gives specific written acceptance of specific deviations.
   5. Do not proceed with purchasing, fabrication or delivery of work which requires submittals until return of submittals with Architect/Engineer stamp and initials or signature evidencing final review and approval of submittals.
   6. Contractor is responsible for dimensions at job site, quantities, coordinating component parts and trades to effect unified construction and implement construction techniques, safety of incremental units, and satisfactory performance of work in accordance with Contract Documents.
   7. Delays caused by failure of Contractor to check shop drawings and to stamp with this approval shall be Contractor's responsibility.
   8. Coordinate preparation and processing of submittals with performance of work to avoid delays.
   9. No extension of time shall be allowed because of failure to properly coordinate and sequence submittals.

C. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
   1. Submit electronic submittals via email or FTP as PDF format electronic files.
      a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
   2. Action Submittals: Submit paper copies of each submittal unless otherwise indicated. Architect and his consultants involved in review of each submittal will retain one copy each; and will annotate and return additional copies to Contractor.
   3. Informational Submittals: Submit **[electronic] [or] [two paper]** copies of each submittal unless otherwise indicated. Architect will not return copies.
   4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be

signed by an officer or other individual authorized to sign documents on behalf of that entity.

D. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.
      f. Application of testing agency labels and seals.
      g. Notation of coordination requirements.
      h. Availability and delivery time information.
   4. For equipment, include the following in addition to the above, as applicable:
      a. Wiring diagrams showing factory-installed wiring.
      b. Printed performance curves.
      c. Operational range diagrams.
      d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
   5. Submit Product Data before or concurrent with Samples.

E. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless the submittal is based on Architect's digital data drawing files, and is specifically permitted.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.
   2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 x 11 inches, but no larger than 30 x 42 inches .
   3. Submit Shop Drawings in one of the following format**s**:
      a. PDF electronic file.
         1) Architect retains the right, at Architect's sole discretion, to require paper copies for submittals that may require extensive annotation on submittal sheets, and for oversize sheets or other conditions that may be difficult to review in electronic format. In each case, Architect and Architect's consultants involved in review will retain one copy each and return the remainder of copies with annotations.
      b. Opaque paper copies of each submittal. Architect and his consultants involved in review will retain one copy each; remainder will be returned.

F. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of applicable Specification Section.
   e. Specification paragraph number and generic name of each item.
3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   a. Number of Samples: Unless otherwise indicated, submit **one** full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
   b. Selector sheets printed by Contractor, and website information, are not acceptable samples for selection. Submit Manufacturer's selector sheets and samples with accurate color and texture representation as applicable.
6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   a. Number of Samples: Unless otherwise indicated, submit two sets of Samples. Architect will retain both Sample sets.
      1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least two sets of paired units that show approximate limits of variations.

G. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
   1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
   2. Manufacturer and product name, and model number if applicable.
   3. Number and name of room or space.

4. Location within room or space.
5. Submit product schedule in the following format:
    a. PDF electronic file.

2.02 INFORMATION SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.
    1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Architect will not return copies.
    2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
    3. Test and Inspection Reports: Comply with requirements in Division 1 Section - Quality Requirements.

B. Coordination Drawing Submittals: Comply with requirements specified in Division 01 Section - Project Management and Coordination.

C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section - Construction Progress Documentation.

D. Application for Payment and Schedule of Values: Comply with requirements specified in Division 01 Section - Payment Procedures.

E. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Division 01 Section - Quality Requirements.

F. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section - Closeout Procedures.

G. Maintenance Data: Comply with requirements specified in Division 01 Section - Operation and Maintenance Data.

H. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

I. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

J. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

K. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

L. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

M. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

N. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

O. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

P. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   1. Name of evaluation organization.
   2. Date of evaluation.
   3. Time period when report is in effect.
   4. Product and manufacturers' names.
   5. Description of product.
   6. Test procedures and results.
   7. Limitations of use.

Q. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

R. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

S. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

T. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.03 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Project Closeout and Maintenance Material Submittals: See requirements in Division 01 Section - Closeout Procedures.

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.02 ARCHITECT'S ACTION

A. Action Submittals:
   1. Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
      a. No exceptions taken.
      b. Make corrections as noted.
      c. Revise and resubmit.
      d. Rejected.
      e. Other.
   2. Submittals or items stamped "No exceptions taken" indicates that Architect does not require resubmittal, and may include comments such as Architect's selection of options.
   3. Submittals or items stamped "Make corrections as noted" indicates that Architect does not require resubmittal if the annotated corrections are made. However, items or submittals with this action noted may require resubmittal if:
      a. Contractor believes indicated corrections are not correct responses, and requires subsequent review. Resubmittal should indicate Contractor's reasons for concern and additional supporting information as applicable.
      b. Contractor believes a resubmittal is required to address or confirm additional questions through subsequent review, related to items not considered by the original submittal or that were brought to light by Architect's previous review comments.
   4. Revise and resubmit items or submittals stamped "revise and resubmit" and "rejected", to address all comments requiring resubmittal and the reasons for rejection.
   5. When "Other" action is indicated, Architect will provide additional comment describing the subsequent action required.
   6. Submittals may be stamped with more than one action regarding portions of the submittal, and may note that only portions of the original submittal are required to be resubmitted.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:
   1. Division 1 Section - Allowances for testing and inspecting allowances.
   2. Division 1 Section - Construction Progress Documentation for developing a schedule of required tests and inspections.
   3. Division 1 Section - Cutting and Patching for repair and restoration of construction disturbed by testing and inspecting activities.
   4. Divisions 2 - 48 Sections for additional specific test and inspection requirements.

1.03 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Mockups establish the standard by which the Work will be judged.

D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

E. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.04 DELEGATED DESIGN

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.05 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.06 REGULATORY REQUIREMENTS

A. Copies of Regulations: Obtain copies of the following regulations and retain at Project site to be available for reference by parties who have a reasonable need:
   1. Texas Accessibility Standards.

1.07 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
   1. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Description of test and inspection.
   3. Identification of applicable standards.
   4. Identification of test and inspection methods.
   5. Number of tests and inspections required.
   6. Time schedule or time span for tests and inspections.
   7. Entity responsible for performing tests and inspections.

8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

E. Reports: Prepare and submit certified written reports that include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

F. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.08 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.
   1. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

H. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in location and of size indicated in drawings or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship.
   4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed, unless otherwise indicated.

1.09 QUALITY CONTROL

A. Owner Responsibilities: The Owner will hire and pay for tests and inspections, unless explicitly assigned to Contractor. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
   1. Contractor shall engage and pay for Mechanical HVAC systems testing adjusting and balancing services. Refer to Division 23 for Testing, Adjusting and Balancing specifications.
   2. Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
   3. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged by Owner and a description of the types of testing and inspecting they are engaged to perform.
   4. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.
   1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.
   2. Notify testing agencies, Engineer & Architect at least 72 hours in advance of time when Work that requires testing or inspecting will be performed.
   3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Special Tests and Inspections: Engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.

1. Testing agency will notify Architect**,** and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
3. Testing agency will submit a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
4. Testing agency will interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
5. Testing agency will retest and re-inspect corrected work.

D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.

E. Retesting/Reinspections: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspections, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
3. Submit a certified written report of each test, inspection, and similar quality-control service to recipients on the distribution list as established by Architect, or in the absence of that, through Contractor.
4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
5. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field-curing of test samples.
5. Delete first subparagraph below if not required or common practice in Project vicinity.
6. Delivery of samples to testing agencies.
7. Preliminary design mix proposed for use for material mixes that require control by testing agency.
8. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for the Notice to Proceed.
   1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 EARTHWORK AND TESTING

A. Inspect and approve subgrade prior to placing material.

B. Perform relative compaction testing determined as outlined in ASTM D-1557.

C. Perform moisture density test for each soil type determined as outlined in ASTM D-698.

D. Field density tests shall be made at all fill areas at backfill and at existing subgrade; no less than two tests per lift.

E. Filling and Backfilling:
   1. The Contractor shall make available to the laboratory, adequate samples of each fill and backfill material from the proposed sources of supply not less than 10 days prior to the start of the work.
   2. The Laboratory shall analyze the samples as required to provide a soil description and to determine compliance with the quality requirements.
      a. Test for liquid limit in accordance with ASTM D423.
      b. Test for plastic limit of soils and plasticity index of soils in accordance with ASTM D424.
      c. Test for moisture density relations of soil in accordance with ASTM D698.
   3. Furnish a report for each individual test and state whether sample conforms to the specified requirements or reasons for nonconformance.
   4. Inspect and approve subgrade prior to placement of fill material.
   5. Make in-place compaction tests for moisture content, moisture-density relationship, and density of fill materials.
   6. Perform not less than two compaction tests for each 3,000 SF of surface for each layer of fill under the building and not less than two compaction tests for each 5,000 SF of surface for each layer of fill or undisturbed earth on areas of site to be covered by paving walks or traffic approaches.

3.02 CONCRETE REINFORCEMENT TESTING AND INSPECTION

A. Reinforcing Bar Inspection: Inspect reinforcing bar placement including size, number, configuration, locations, clearances, and related criteria.

B. Reinforcing: Inspect all reinforcing steel prior to placement of concrete for compliance with the Contract Documents and the approved shop drawings. All instances of noncompliance shall be immediately brought to the attention of the Contractor. If uncorrected by the contractor, they shall be listed in the report.
   1. Observe and report the following: number and size of bars; bending; splicing; clearance to forms; clearance between bars; rust, from oil or other contamination; fabrication and installation of embedded metal assemblies, including visual inspection of all welds.

C. Inspector shall have a minimum of three years experience inspecting reinforcing steel in projects of similar size.

3.03 CAST-IN-PLACE CONCRETE TESTING AND INSPECTION

A. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Architect for final acceptance.

B. Testing agencies shall meet the requirements of "Recommended Practice for Inspection and Testing Agencies for Concrete and Steel in Construction", ASTM E-329-70.

C. The following review and testing services shall be performed by the designated laboratory:
   1. The testing laboratory shall review the submitted mix designs for conformance with "Building Code Requirements for Structural Concrete" ACI 318-95.
   2. Secure composite samples in accordance with "Method of Sampling Fresh Concrete" ASTM C172, Current Edition.
   3. Mold and cure five specimens from each sample in accordance with "Method of Making and Curing Concrete Compression and Flexural Specimens in the Field", ASTM C31, Current Edition.
   4. Test specimens in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders", ASTM C39, Current Edition. Two specimens shall be tested at 28 days for acceptance and two shall be tested at 7 days for information. The remaining cylinder shall be tested as directed.
   5. Make one strength test for each 100 cubic yards or fraction thereof, of each mix design or concrete placed in any one day.
   6. Determine slump for each strength test and whenever consistency of concrete appears to vary, using "Method of Test for Slump of Portland Cement Concrete" ASTM C143, Current Edition and air content of normal weight or light weight concrete sample for each strength test.
   7. Determine temperature of concrete sample for each strength test.
   8. Other testing services needed or required shall be paid by the Contractor.
   9. Inspect and control the concrete mixing and loading of transit-mix trucks at the plant at the start of each day's mixing. Check mixing from mixers before mix begins to set and within time limits set forth in ASTM C94. Prevailing conditions shall be compared to the criteria indicated on the appropriate design mix (temperature, moisture, condition of aggregates, etc.).
   10. Any significant deviance shall be immediately reported to the Architect and the design laboratory and corresponding adjustments to the mix made before any materials are discharged.
   11. Control the addition of water to the concrete at the job site and the length of time the concrete is allowed to remain in the truck during the pour.
   12. Specimens for pumped concrete shall be taken at the discharge and of pumping equipment.
   13. Certify each delivery ticket indicating class of concrete delivered (or poured), amount of water added and the time at which the cement and aggregate was discharged into the truck, and the time at which the concrete was discharged from the truck.

D. Provide and maintain for the use of the testing agency adequate facilities for proper curing of concrete test specimens on the project site in accordance with "Methods of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31, Current Edition.

E. Evaluation and Acceptance:
   1. The strength level of the concrete will be considered satisfactory if 90% of the strength test results and the averages of all sets of three consecutive strength test results equal or exceed specified strength and no individual test result is below specified strength by more than 500 psi.

2. Completed concrete work will be accepted when the requirements of "Specifications for Structural Concrete for Buildings" ACI 301-84, Chapter 18 have been complied with.
3. In any case, where the average strength of the laboratory control cylinders, as shown by the tests for any portion of the structure, falls below the minimum ultimate compressive strength hereinbefore specified, the Architect shall have the right to require the Contractor to provide improved curing conditions of temperature and moisture to secure the required strength. Also, if the average strength of the laboratory control cylinders should fall so low as to cause the portions of the structure to which the respective unsatisfactory test reports apply to be in question by the Architect, the Contractor shall follow the core procedure set forth in the current edition of ASTM Designation C42. If the results of the core tests indicate, in the opinion of the Architect, that the strength of the structure is inadequate, such replacement, load testing, or strengthening as may be ordered by the Architect shall be provided by the Contractor without cost to the Owner.
4. The testing laboratory shall control field adjustments made to concrete mixes to compensate for field conditions and report same.
5. Wherever the testing laboratory recognizes a trend of decreasing quality in the concrete due to changing reasons, conditions of curing or other cause; this shall be brought to the attention of the Architect, along with a recommendation for corrective action to be taken before the materials fall below the requirements of these Specifications.

F. Reports: In addition, the testing laboratory shall make one copy of the reports to the concrete supplier.

3.04 INSPECTING STRUCTURAL STEEL

A. Field Inspection
1. Proper erection of all pieces.
2. Proper installation of all bolts, including checking the calibration of impact wrenches used with high strength bolts.
3. Plumbness of structure and proper bracing.
4. Ultrasonic inspection of all full penetration welds.
5. Record and measure camber of beams upon arrival and before erection with compliance with the specified camber. Measure beam lying flat with web in the horizontal position. Members outside the specified camber tolerance shall be returned to the shop.

B. Qualification of Welders: Before assigning any welder to work covered by this section of the Specifications, the fabricator shall provide the Testing Laboratory with certification that each of the the welders to be employed on the project has passed qualification tests within the last year using procedures covered in the American Welding Society Standard D1.0-63.

C. The contractor shall be responsible for furnishing fabrication and erection inspection and testing of all welds in accordance with AWS D1.1, Chapter 6. Submit records of inspections and tests to the Owner’s testing laboratory for their review.

D. Inspection of shop and field welding shall be “verification inspection” in accordance with Section 6 of AWS D1.1 and as follows:
1. Visually inspect the welding of all shop fabricated members and note the location of all cover plates, connectors, bearing stiffeners, splices, and fillet welds for proper return around ends and check for seams, folds, and delamination.
2. Ultrasonically test all full penetration welds in accordance with ASTM E164.
3. Root passes shall be thoroughly be inspected for cracks. All cracks shall be gouged out and rewelded to two inches beyond each end of the crack.
4. Mark all welds requiring repairs and make reinspections.

5. The Testing Laboratory inspector shall advise the Owner and Architect of any shop and/or field conditions which, in his opinion, may require further tests and examination. Such further tests shall be performed as authorized by the Owner and Architect.
6. The Owner reserves the right to use ultrasonic or radiographic inspection to verify the adequacy of all welds. Testing procedures and acceptance criteria shall be as specified in AWS D1.1.

E. Inspection of bolted construction shall be in accordance with AISC "Specification for Structural Steel Buildings" and as follows:
1. All bolts shall be visually inspected to ensure that the plies have been brought into "snug" contact.
2. High strength bolts shall be inspected in accordance with Section 9 of the AISC "Specifications for Structural Joints Using ASTM A325 or A490 Bolts." Bolts are to be fully torqued as required by the AISC specification.
3. For all high strength bolts, the inspector shall observe the required jobsite testing and calibration, and shall confirm that the procedure to be used provides the required tension.

3.05 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Comply with the Contract Document requirements for Division 1 Section - Cutting and Patching.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCE STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built. Refer to Division 01 "Work Restrictions".

1.03 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are

minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.04 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.
   1. Where abbreviations and acronyms used in Specifications or other Contract Documents are not listed, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

AABC	Associated Air Balance Council www.aabc.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.americanbearings.org	(202) 367-1155
ACI	American Concrete Institute (Formerly: ACI International) www.concrete.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The) www.ahrinet.org	(703) 524-8800
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction	(303) 792-9559

	www.aitc-glulam.org	
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts, Inc. www.aosaseed.com	(607) 256-3313
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute (See AHRI)	
ARI	American Refrigeration Institute (See AHRI)	
ARMA	Asphalt Roofing Manufacturers Association www.asphaltroofing.org	(202) 207-0917
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (American Society of Mechanical Engineers) www.asme.org	(800) 843-2763 (973) 882-1170
ASSE	American Society of Safety Engineers (The) www.asse.org	(847) 699-2929
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9500
ATIS	Alliance for Telecommunications Industry Solutions www.atis.org	(202) 628-6380
AWEA	American Wind Energy Association www.awea.org	(202) 383-2500
AWI	Architectural Woodwork Institute www.awinet.org	(571) 323-3636
AWMAC	Architectural Woodwork Manufacturers Association of Canada www.awmac.com	(403) 453-7387
AWPA	American Wood Protection Association (Formerly: American Wood-Preservers' Association) www.awpa.com	(205) 733-4077
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.gobrick.com	(703) 620-0010

BICSI	BICSI, Inc. www.bicsi.org	(800) 242-7405 (813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.org	(866) 342-4772
BWF	Badminton World Federation (Formerly: International Badminton Federation) www.bwfbadminton.org	60 3 9283 7155
CDA	Copper Development Association www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Consumer Electronics Association www.ce.org	(866) 858-1555 (703) 907-7600
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CFSEI	Cold-Formed Steel Engineers Institute www.cfsei.org	(866) 465-4732 (202) 263-4488
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(404) 622-0073
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPA	Composite Panel Association www.pbmdf.com	(703) 724-1128
CRI	Carpet and Rug Institute (The) www.carpet-rug.org	(706) 278-3176
CRRC	Cool Roof Rating Council www.coolroofs.org	(866) 465-2523 (510) 485-7175
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(800) 328-6306 (847) 517-1200
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(866) 797-4272 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
CWC	Composite Wood Council (See CPA)	
DASMA	Door and Access Systems Manufacturers Association www.dasma.com	(216) 241-7333
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
ECA	Electronic Components Association www.ec-central.org	(703) 907-8024
ECAMA	Electronic Components Assemblies & Materials Association	

	(See ECA)	
EIA	Electronic Industries Alliance (See TIA)	
EIMA	EIFS Industry Members Association www.eima.com	(800) 294-3462 (703) 538-1616
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association (Electrostatic Discharge Association) www.esda.org	(315) 339-6937
ESTA	Entertainment Services and Technology Association (See PLASA)	
EVO	Efficiency Valuation Organization www.evo-world.org	(415) 367-3643 44 20 88 167 857
FM Approvals	FM Approvals LLC www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridaroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council U.S. www.fscus.org	(612) 353-4511
GA	Gypsum Association www.gypsum.org	(301) 277-8686
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GS	Green Seal www.greenseal.org	(202) 872-6400
HI	Hydraulic Institute www.pumps.org	(973) 267-9700
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association (See AHRI)	
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAPSC	International Association of Professional Security Consultants www.iapsc.org	(415) 536-0288
IAS	International Approval Services (See CSA)	
ICBO	International Conference of Building Officials (See ICC)	
ICC	International Code Council www.iccsafe.org	(888) 422-7233 (202) 370-1800
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369
ICPA	International Cast Polymer Alliance www.icpa-hq.org	(703) 525-0511
ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830

IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IES	Illuminating Engineering Society (Formerly: Illuminating Engineering Society of North America) www.ies.org	(212) 248-5000
IESNA	Illuminating Engineering Society of North America (See IES)	
IEST	Institute of Environmental Sciences and Technology www.iest.org	(847) 981-0100
IGMA	Insulating Glass Manufacturers Alliance www.igmaonline.org	(613) 233-1510
IGSHPA	International Ground Source Heat Pump Association www.igshpa.okstate.edu	(405) 744-5175
Intertek	Intertek Group (Formerly: ETL SEMCO; Intertek Testing Service NA) www.intertek.com	(800) 967-5352
ISA	International Society of Automation (The) (Formerly: Instrumentation, Systems, and Automation Society) www.isa.org	(919) 549-8411
ISAS	Instrumentation, Systems, and Automation Society (The) (See ISA)	
ISFA	International Surface Fabricators Association (Formerly: International Solid Surface Fabricators Association) www.isfanow.org	(877) 464-7732 (801) 341-7360
ISO	International Organization for Standardization www.iso.org	41 22 749 01 11
ISSFA	International Solid Surface Fabricators Association (See ISFA)	
ITU	International Telecommunication Union www.itu.int/home	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LMA	Laminating Materials Association (See CPA)	
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(847) 375-4718
MFMA	Maple Flooring Manufacturers Association, Inc. www.maplefloor.org	(888) 480-9138
MFMA	Metal Framing Manufacturers Association, Inc. www.metalframingmfg.org	(312) 644-6610
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MMPA	Moulding & Millwork Producers Association (Formerly: Wood Moulding & Millwork Producers Association) www.wmmpa.com	(800) 550-7889 (530) 661-9591
MPI	Master Painters Institute	(888) 674-8937

	www.paintinfo.com	(604) 298-7578
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.org	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(630) 942-6591
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(800) 797-6223 (281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCAA	National Collegiate Athletic Association (The) www.ncaa.org	(317) 917-6222
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(888) 300-6382 (269) 488-6382
NFHS	National Federation of State High School Associations www.nfhs.org	(317) 972-6900
NFPA	NFPA (National Fire Protection Association) www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NHLA	National Hardwood Lumber Association www.nhla.com	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association (See NWFA)	
NOMMA	National Ornamental & Miscellaneous Metals Association www.nomma.org	(888) 516-8585
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NSPE	National Society of Professional Engineers www.nspe.org	(703) 684-2800
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The) www.ntma.com	(800) 323-9736

NWFA	National Wood Flooring Association www.nwfa.org	(800) 422-4556 (636) 519-9663
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (978) 557-0720
PLASA	PLASA (Formerly: ESTA - Entertainment Services and Technology Association) www.plasa.org	(212) 244-1505
RCSC	Research Council on Structural Connections www.boltcouncil.org	
RFCI	Resilient Floor Covering Institute www.rfci.com	(706) 882-3833
RIS	Redwood Inspection Service www.redwoodinspection.com	(925) 935-1499
SAE	SAE International (Society of Automotive Engineers) www.sae.org	(877) 606-7323 (724) 776-4841
SBCCI	Southern Building Code Congress International, Inc. (See ICC)	
SCTE	Society of Cable Telecommunications Engineers www.scte.org	(800) 542-5040 (610) 363-6888
SDI	Steel Deck Institute www.sdi.org	(847) 458-4647
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabs.com	(877) 294-5424 (516) 294-5424
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)	
SIA	Security Industry Association www.siaonline.org	(866) 817-8888 (703) 683-2075
SJI	Steel Joist Institute www.steeljoist.org	(843) 293-1995
SMA	Screen Manufacturers Association www.smainfo.org	(773) 636-0672
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
SMPTE	Society of Motion Picture and Television Engineers www.smpte.org	(914) 761-1100
SPFA	Spray Polyurethane Foam Alliance www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau www.spib.org	(850) 434-2611
SPRI	Single Ply Roofing Industry www.spri.org	(781) 647-7026
SRCC	Solar Rating and Certification Corporation www.solar-rating.org	(321) 638-1537
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute	(847) 438-8265

	www.steeltank.com	
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWPA	Submersible Wastewater Pump Association www.swpa.org	(847) 681-1868
TCA	Tilt-Up Concrete Association www.tilt-up.org	(319) 895-6911
TCA	Tile Council of America (See TCNA)	
TCNA	Tile Council of North America, Inc. (Formerly: Tile Council of America) www.tileusa.com	(864) 646-8453
TEMA	Tubular Exchanger Manufacturers Association, Inc. www.tema.org	(914) 332-0040
TIA	Telecommunications Industry Association (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance) www.tiaonline.org	(703) 907-7700
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance (See TIA)	
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute www.tpinst.org	(703) 683-1010
TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 649-5555
TRI	Tile Roofing Institute www.tileroofing.org	(312) 670-4177
UBC	Uniform Building Code (See ICC)	
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USAV	USA Volleyball www.usavolleyball.org	(888) 786-5539 (719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(800) 795-1747
USITT	United States Institute for Theatre Technology, Inc. www.usitt.org	(800) 938-7488 (315) 463-6463
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association www.wcmanet.org	(212) 297-2122
WDMA	Window & Door Manufacturers Association www.wdma.com	(800) 223-2301 (312) 321-6802
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California) www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association (See MMPA)	
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 938-5441
WWPA	Western Wood Products Association	(503) 224-3930

www.wwpa.org

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DIN	Deutsches Institut für Normung e.V. www.din.de	49 30 2601-0
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICC	International Code Council www.iccsafe.org	(888) 422-7233
ICC-ES	ICC Evaluation Service, LLC www.icc-es.org	(800) 423-6587 (562) 699-0543

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

COE	Army Corps of Engineers www.usace.army.mil	(202) 761-0011
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce National Institute of Standards and Technology www.nist.gov	(301) 975-4040
DOD	Department of Defense http://dodssp.daps.dla.mil	(215) 697-2664
DOE	Department of Energy www.energy.gov	(202) 586-9220
EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
FAA	Federal Aviation Administration www.faa.gov	(866) 835-5322
FG	Federal Government Publications www.gpo.gov	(202) 512-1800
GSA	General Services Administration www.gsa.gov	(800) 488-3111 (202) 619-8925
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory Environmental Energy Technologies Division http://eetd.lbl.gov	(510) 486-4000
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742
TRB	Transportation Research Board National Cooperative Highway Research Program www.trb.org	(202) 334-2934
USDA	Department of Agriculture Rural Utilities Service www.usda.gov	(202) 720-2791
USDJ	Department of Justice Office of Justice Programs National Institute of Justice	(202) 307-0703

	www.ojp.usdoj.gov	
USP	U.S. Pharmacopeia	(800) 227-8772
	www.usp.org	(301) 881-0666
USPS	United States Postal Service	(202) 268-2000
	www.usps.com	

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ABA /	Architectural Barriers Act	(800) 872-2253
ADA /	Americans with Disabilities Act	
ADAAG	Americans with Disabilities Act Accessibility Guidelines	
	Administered by the United States Access Board	
	http://www.access-board.gov/	
CFR	Code of Federal Regulations	(866) 512-1800
	Available from Government Printing Office	(202) 512-1800
	www.gpo.gov/fdsys	
DOD	Department of Defense	(215) 697-2664
	Military Specifications and Standards	
	Available from Department of Defense Single Stock Point	
	http://dodssp.daps.dla.mil	
FED-STD	Federal Standard	
	(See FS)	
FS	Federal Specification	(215) 697-2664
	Available from Department of Defense Single Stock Point	
	http://dodssp.daps.dla.mil	
	Available from Defense Standardization Program	
	www.dsp.dla.mil	
	Available from General Services Administration	(800) 488-3111
	www.gsa.gov	(202) 619-8925
	Available from National Institute of Building Sciences/Whole Building Design Guide	(202) 289-7800
	www.wbdg.org/ccb	
MILSPEC	Military Specification and Standards	
	(See DOD)	
TAS	Texas Accessibility Standards	(512) 539 5669
	Administered by the Texas Department of Licensing and Registration	
	http://www.tdlr.texas.gov/ab/ab.htm	
UFAS	Uniform Federal Accessibility Standards	(800) 872-2253
	Administered by the United States Access Board	
	http://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-aba-standards/ufas	
USAB	United States Access Board	(800) 872-2253
	www.access-board.gov	(202) 272-0080
USATBCB	U.S. Architectural & Transportation Barriers Compliance Board	
	(See USAB)	

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CBHF	State of California	(800) 952-5210
	Department of Consumer Affairs	(916) 574-2041
	Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal	

	Insulation www.bearhfti.ca.gov	
CCR	California Code of Regulations Office of Administrative Law California Title 24 Energy Code www.calregs.com	(916) 323-6225
CDHS	California Department of Health Care Services (Formerly: California Department of Health Services) (See CCR)	
CDPH	California Department of Public Health Indoor Air Quality Program www.cal-iaq.org	
CPUC	California Public Utilities Commission www.cpuc.ca.gov	(800) 848-5580 (415) 703-2782
SCAQMD	South Coast Air Quality Management District www.aqmd.gov	(909) 396-2000
TCEQ	Texas Commission on Environmental Quality http://www.tceq.state.tx.us/	(512) 239-1000
TDLR	Texas Department of Licensing and Registration http://www.tdlr.texas.gov/index.htm	(800) 803-9202
TFS	Texas Forest Service Forest Resource Development and Sustainable Forestry http://txforestservice.tamu.edu	(979) 458-6606
TxDOT	Texas Department of Transportation www.txdot.gov	(800) 558-9368

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.

B. Temporary utilities include, but are not limited to, the following:
   1. Sewers and drainage.
   2. Water service and distribution.
   3. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
   4. Heating and cooling facilities.
   5. Ventilation.
   6. Electric power service.
   7. Lighting.
   8. Telephone service.

C. Support facilities include, but are not limited to, the following:
   1. Temporary roads and paving.
   2. Dewatering facilities and drains.
   3. Project identification and temporary signs.
   4. Waste disposal facilities.
   5. Field offices.
   6. Storage and fabrication sheds.
   7. Lifts and hoists.
   8. Temporary elevator usage.
   9. Temporary stairs.
   10. Construction aids and miscellaneous services and facilities.

D. Security and protection facilities include, but are not limited to, the following:
   1. Environmental protection.
   2. Stormwater control.
   3. Tree and plant protection.
   4. Pest control.
   5. Site enclosure fence.
   6. Security enclosure and lockup.
   7. Barricades, warning signs, and lights.
   8. Covered walkways.
   9. Temporary enclosures.
   10. Temporary partitions.
   11. Fire protection.

E. Related Sections include the following:
   1. Division 1 Section - Submittal Procedures for procedures for submitting copies of implementation and termination schedule and utility reports.
   2. Division 1 Section - Execution Requirements for progress cleaning requirements.
   3. Divisions 2 through 48 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.

1.03 DEFINITIONS

A. Permanent Enclosure: As determined by Architect, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

1.04 USE CHARGES

A. General: Cost or use charges for temporary facilities are not chargeable to Owner or Architect and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:
   1. Owner's maintenance personnel.
   2. Occupants of Project.
   3. Architect.
   4. Testing agencies.
   5. Personnel of authorities having jurisdiction.

B. Sewer Service: If necessary, use sewer service from Owner's municipal utility services free of charge.

C. Water Service: Use water from Owner's municipal utility services without metering and without payment of use charges.

D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.05 SUBMITTALS

A. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

1.06 QUALITY ASSURANCE

A. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
   1. Trade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
   2. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.07 PROJECT CONDITIONS

A. Temporary Utilities: At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.
   1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

B. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
   1. Keep temporary services and facilities clean and neat.

2. Relocate temporary services and facilities as required by progress of the Work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Architect. Provide materials suitable for use intended.

B. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.

C. Portable Chain-Link Fencing: Minimum 2-inch 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete or galvanized steel bases for supporting posts.

D. Lumber and Plywood: Comply with requirements in Division 6 Section - Carpentry.

E. Gypsum Board: Minimum 1/2 inch thick by 48 inches wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36.

F. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively.

G. Paint: Comply with requirements in Division 9 Section - Painting.

H. Tarpaulins: Fire-resistive labeled with flame-spread rating of 15 or less.

I. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.

J. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches

K. Water: Potable.

2.02 EQUIPMENT

A. General: Provide equipment suitable for use intended.

B. Field Offices: Prefabricated Mobile units with lockable entrances, operable windows, and serviceable finishes; heated and air conditioned; on foundations adequate for normal loading.

C. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and tack & marker boards.
3. Drinking water and private toilet.
4. Coffee machine and supplies.
5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
6. Lighting fixtures capable of maintaining average illumination of 20 fc.

D. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations. Store combustible materials apart from building.

E. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
   1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

F. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

G. Drinking-Water Fixtures: Containerized, tap-dispenser, bottled-water drinking-water units, including paper cup supply.
   1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.

H. Heating Equipment: Unless Owner authorizes use of permanent heating system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
   1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   2. Heating Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use for type of fuel being consumed.
   3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of [8] at each return-air grille in system and remove at end of construction and clean HVAC system as required in Division 01 Section - Closeout Procedures.

I. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.

J. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION

A. General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

2. Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
3. Obtain easements to bring temporary utilities to Project site where Owner's easements cannot be used for that purpose.

B. Water Service: Provide temporary water service as required for construction.
1. Provide rubber hoses as necessary to serve Project site.
2. Install water service and distribution piping in sizes and pressures adequate for construction.
3. As soon as water is required at each level, extend service to form a temporary water- and fire-protection standpipe. Provide distribution piping. Space outlets so water can be reached with a 100-foot (30-m) hose. Provide one hose at each outlet.
4. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
5. Provide pumps to supply a minimum of 30-psi static pressure at highest point. Equip pumps with surge and storage tanks and automatic controls to supply water uniformly at reasonable pressures.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities. Existing sanitary facilities and new sanitary facilities shall not be used by contractor personnel.
1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy. Provide separate facilities for male and female personnel.
3. Toilets: Install toilet facilities connected to local water and sewer lines. Provide lavatories, mirrors, urinals, and water closets. Provide only potable-water connections. Provide individual compartments for water closets. Provide suitable enclosure with nonabsorbent sanitary finish materials and adequate heat, ventilation, and lighting.
4. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled.
   a. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
5. Drinking-Water Facilities: Provide bottled-water, drinking-water units.
   a. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.

D. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed.
1. Maintain a minimum temperature of 50 deg F in permanently enclosed portions of building for normal construction activities, and 65 deg F for finishing activities and areas where finished Work has been installed.

E. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed.

Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.

F. Electric Distribution: Provide temporary electric power service as required for construction, including receptacle outlets adequate for connection of power tools and equipment.
   1. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
   2. Provide warning signs at power outlets other than 110 to 120 V.
   3. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or other traffic areas.
   4. Provide metal conduit enclosures or boxes for wiring devices.
   5. Provide 4-gang outlets, spaced so 100-foot extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
   2. Provide one 100-W incandescent lamp per 500 sq. ft., uniformly distributed, for general lighting, or equivalent illumination.
   3. Provide one 100-W incandescent lamp every 50 feet in traffic areas.
   4. Provide one 100-W incandescent lamp per story in stairways and ladder runs, located to illuminate each landing and flight.
   5. Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed.
   6. Install lighting for Project identification sign.

H. Telephone Service: Furnish superintendent with a portable cellular telephone for use in making and receiving telephone calls when away from field office.

I. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Contractor, Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
   1. Processor: Intel Quad-Core, 4.0 GHz processing speed.
   2. Memory: 4 gigabyte.
   3. Disk Storage: 300 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.
   4. Display: 22-inch LED monitor with 256-Mb dedicated video RAM.
   5. Full-size keyboard and mouse.
   6. Network Connectivity: 10/100BaseT Ethernet.
   7. Operating System: Microsoft Windows 8.1 or higher.
   8. Productivity Software:
      a. Microsoft Office, including Word, Excel, and Outlook.
      b. Adobe Reader 11.0 or higher.
      c. WinZip 17.0 or higher.
   9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, or separate units for each of these functions.
   10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 25 Mbps upload and 25 Mbps download speeds at each computer.
   11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.

12. Backup: External hard drive, minimum 80 gigabyte, with automated backup software providing daily backups.

J. Digital Camera: Provide a digital camera for superintendant to transmit photographs to Architect & Owner.

3.03 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
   1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
   2. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
   3. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Traffic Controls: Provide temporary traffic controls at junction of temporary roads with public roads. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. Comply with requirements of authorities having jurisdiction.

C. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas [as indicated] [within construction limits indicated] on Drawings.
   1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

D. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
   1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   2. Prepare subgrade and install sub-base and base for temporary roads and paved areas according to Division 31 Section - Earth Moving.
   3. Recondition base after temporary use, including removing contaminated material, re-grading, proof-rolling, compacting, and testing.
   4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 32 Section - Asphalt Paving.

E. Dewatering Facilities and Drains: Comply with requirements in applicable sections for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. Maintain Project site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property nor endanger permanent Work or temporary facilities.
   2. Before connection and operation of permanent drainage piping system, provide temporary drainage where roofing or similar waterproof deck construction is completed.
   3. Remove snow and ice as required to minimize accumulations.

F. Project Identification and Temporary Signs: Prepare Project identification and other signs in sizes indicated. Install signs where indicated to inform public and persons seeking entrance to Project. Do not permit installation of unauthorized signs.

1. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.
2. Prepare temporary signs to provide directional information to construction personnel and visitors.
3. Construct signs of exterior-type Grade B-B high-density concrete-form overlay plywood in sizes and thicknesses indicated. Support on posts or framing of preservative-treated wood or steel.
4. Paint sign panel and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.
5. Maintain and touchup signs so they are legible at all times.

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste. Comply with Division 1 Section - Execution Requirements for progress cleaning requirements. Comply with requirements specified in Division 1 Section - Construction Waste Management and Disposal.
1. If required by authorities having jurisdiction, provide separate containers, clearly labeled, for each type of waste material to be deposited.
2. Develop a waste management plan for Work performed on Project. Indicate types of waste materials Project will produce and estimate quantities of each type. Provide detailed information for on-site waste storage and separation of recyclable materials. Provide information on destination of each type of waste material and means to be used to dispose of all waste materials.

H. Janitorial Services: Provide janitorial services on a daily basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas.

I. Common-Use Field Office: Provide an insulated, weathertight, air-conditioned field office for use as a common facility by all personnel engaged in construction activities; of sufficient size to accommodate required office personnel and meetings of 10 persons at Project site. Keep office clean and orderly.
1. Furnish and equip offices as follows:
   a. Desk and four chairs, four-drawer file cabinet, a plan table, a plan rack, and bookcase.
   b. Water cooler and private toilet complete with water closet, lavatory, and medicine cabinet with mirror.
   c. Provide a room of not less than 240 sq. ft. for Project meetings. Furnish room with conference table, 12 folding chairs, and 4-foot- square tack board.
2. Provide an electric heater with thermostat capable of maintaining a uniform indoor temperature of 68 deg F. Provide an air-conditioning unit capable of maintaining an indoor temperature of 72 deg F.
3. Provide fluorescent light fixtures capable of maintaining average illumination of 20 fc at desk height. Provide 110- to 120-V duplex outlets spaced at not more than 12-foot intervals, 1 per wall in each room.

J. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.
1. Construct framing, sheathing, and siding using fire-retardant-treated lumber and plywood.
2. Paint exposed lumber and plywood with exterior-grade acrylic-latex emulsion over exterior primer.

K. Lifts and Hoists: Provide facilities for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
   1. Existing Elevator Usage: Use of Owner's existing elevators will be not be permitted.

L. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.

B. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Division 31 Section - Site Clearing.

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion and sedimentation control drawings or requirements of authorities having jurisdiction, whichever is more stringent.
   1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.
   2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
   3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
   4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from construction damage. Protect tree root systems from damage, flooding, and erosion.

F. Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest-control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Engage this pest-control service to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.

G. Site Enclosure Fence: Before construction operations begin, install chain-link enclosure fence with lockable entrance gates. Locate where indicated, or enclose entire Project site or portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering site except by entrance gates.
   1. Set fence posts in concrete bases.

2. Provide gates in sizes and at locations necessary to accommodate delivery vehicles and other construction operations.
3. Option in subparagraph below is only for projects connected to existing construction.
4. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.

H. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each day.

I. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

J. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.
1. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch thick exterior plywood.

K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
2. Vertical Openings: Close openings of 25 sq. ft.or less with plywood or similar materials.
3. Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
4. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.
5. Where temporary wood or plywood enclosure exceeds 100 sq. ft. in area, use fire-retardant-treated material for framing and main sheathing.

L. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise. Prevent from entering occupied areas.
1. Construct dustproof partitions of not less than nominal 4-inch studs, 5/8-inch gypsum wallboard with joints taped on occupied side, and 1/2-inch fire-retardant plywood on construction side.
2. Construct dustproof, floor-to-ceiling partitions of not less than nominal 4-inchstuds, 2 layers of 3-milpolyethylene sheets, inside and outside temporary enclosure. Cover floor with 2 layers of 3-mil polyethylene sheets, extending sheets 18 inchesup the side walls. Overlap and tape full length of joints. Cover floor with 3/4-inchfire-retardant plywood.
    a. Construct a vestibule and airlock at each entrance to temporary enclosure with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
3. Insulate partitions to provide noise protection to occupied areas.
4. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
    a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
    b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

5. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
6. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
7. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
8. Protect air-handling equipment.
9. Weatherstrip openings.

M. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
1. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.
   a. Field Offices: Class A stored-pressure water-type extinguishers.
   b. Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.
   c. Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
2. Store combustible materials in containers in fire-safe locations.
3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting. Provide temporary key boxes and knox padlocks for gates and secured areas throughout construction as required by authorities having jurisdiction.
4. Prohibit smoking in construction areas.
5. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
6. Permanent Fire Protection: At earliest feasible date in each area of Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
7. Develop and supervise an overall fire-prevention and first-aid fire-protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
8. Provide hoses for fire protection of sufficient length to reach construction areas. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.
9. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.05 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
   1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
   2. Keep interior spaces reasonably clean and protected from water damage.
   3. Periodically collect and remove waste containing cellulose or other organic matter.
   4. Discard or replace water-damaged material.
   5. Do not install material that is wet.
   6. Discard, replace, or clean stored or installed material that begins to grow mold.
   7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
   1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
   2. Use permanent HVAC system to control humidity.
   3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits:
      a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
      b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
      c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.06 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
   2. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.

D. Temporary Facility Changeover: Except for using permanent fire protection as soon as available, do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

E. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
   1. Materials and facilities that constitute temporary facilities are the property of Contractor. Owner reserves right to take possession of Project identification signs.

2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Division 1 Section - Closeout Procedures.

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Sections include the following:
   1. Division 1 Section - Allowances for products selected under an allowance.
   2. Division 1 Section - Alternates for products selected as an alternate.
   3. Division 1 Section - Substitutions for products selected as a substitute.
   4. Division 1 Section - References for applicable industry standards for products specified.
   5. Division 1 Section - Closeout Procedures for submitting warranties for contract closeout.
   6. Divisions 2 - 48 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.03 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.04 SUBMITTALS

A. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
   1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
   2. Form: Tabulate information for each product under the following column headings:
      a. Specification Section number and title.
      b. Generic name used in the Contract Documents.
      c. Proprietary name, model number, and similar designations.
      d. Manufacturer's name and address.
      e. Supplier's name and address.
      f. Installer's name and address.
      g. Projected delivery date or time span of delivery period.
      h. Identification of items that require early submittal approval for scheduled delivery date.
   3. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
      a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
   4. Completed List: Within 30 days after date of commencement of the Work, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
   5. Architect's Action: Architect will respond in writing to Contractor within 15 working days of receipt of completed product list if there are objections to the list. Architect's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Architect's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section - Submittal Procedures. Show compliance with requirements.

1.05 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
   1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
   2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products to allow for inspection and measurement of quantity or counting of units.
6. Store materials in a manner that will not endanger Project structure.
7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
8. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
9. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
10. Protect stored products from damage and liquids from freezing.
11. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.07 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Refer to Divisions 2 through 48 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 1 Section - Closeout Procedures.

PART 2 - PRODUCTS

2.01 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Architect will make selection.
   5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.

6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal", "or approved equal", "or approved," or “acceptable substitution”, comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures: Procedures for product selection include the following:
   1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
      a. Substitutions may be considered, unless otherwise indicated.
   2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
      a. Substitutions may be considered, unless otherwise indicated.
   3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
      a. Substitutions may be considered, unless otherwise indicated.
   4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
      a. Substitutions may be considered, unless otherwise indicated.
   5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
   6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
   7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Product Substitutions" Article.
   8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Products" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
      a. Substitutions may be considered, unless otherwise indicated.
   9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches satisfactorily.

a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.

10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.
11. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

2.02 COMPARABLE PRODUCTS

A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
   1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
   2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   3. Evidence that proposed product provides specified warranty.
   4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
   5. Samples, if requested.

PART 3 - EXECUTION

Not Used.

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. Field engineering and surveying.
   3. Installation of the Work.
   4. Cutting and patching.
   5. Coordination of Owner-installed products.
   6. Progress cleaning.
   7. Starting and adjusting.
   8. Protection of installed construction.
   9. Correction of the Work.

B. Related Requirements:
   1. Division 01 Section - Summary for limits on use of Project site.
   2. Division 01 Section - Submittal Procedures for submitting surveys.
   3. Division 01 Section - Cutting and Patching for cutting and patching necessary for installation or performance of other components of the work.
   4. Division 01 Section - Closeout Procedures for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
   5. Division 07 Section - Penetration Firestopping for patching penetrations in fire-rated construction.

1.03 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
   1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
   2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.

3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
    a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.05 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
    1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
        a. Primary operational systems and equipment.
        b. Fire separation assemblies.
        c. Air or smoke barriers.
        d. Fire-suppression systems.
        e. Mechanical systems piping and ducts.
        f. Control systems.
        g. Communication systems.
        h. Fire detection and alarm systems.
        i. Conveying systems.
        j. Electrical wiring systems.
        k. Operating systems of special construction.
    2. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
        a. Water, moisture, or vapor barriers.
        b. Membranes and flashings.
        c. Exterior curtain-wall construction.
        d. Sprayed fire-resistive material.
        e. Equipment supports.
        f. Piping, ductwork, vessels, and equipment.
        g. Noise- and vibration-control elements and systems.
    3. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of

potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Comply with requirements specified in other Sections.
   1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Division 01 sustainable design requirements Section.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
   3. In the event of any inconsistency or conflict, between existing conditions and the bidding documents, immediate notice of such inconsistency or conflict shall be given to the Architect. Do not undertake any phase of the work affected by such inconsistency or conflict, pending the issuance of instructions by the Architect.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
   2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
   1. Description of the Work.
   2. List of detrimental conditions, including substrates.
   3. List of unacceptable installation tolerances.

4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Existing Utility Information: Furnish information to local utility or Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Division 01 Section - Project Management and Coordination.

3.03 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
   1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
   2. Establish limits on use of Project site.
   3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
   4. Inform installers of lines and levels to which they must comply.
   5. Check the location, level and plumb, of every major element as the Work progresses.
   6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
   7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Elevations of existing grades, floors, tops of walls, parapets, beams and locations of existing columns, walls and the like are based on survey documents or on drawings of the existing building furnished by the Owner. The Architect assumes no responsibility for the accuracy of the information on existing drawings. It is the intent of the Contract Drawings to integrate new work with existing improvements and for the Contractor to verify actual conditions.

E. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

F. Subcontractors shall verify with the General Contractor the exact field location of all rough-in dimensions, taking into account location of walls, partitions and equipment. Special attention should be paid to clearances as required for compliance with American's with Disabilities Act Accessibility Guidelines (ADAAG) in the state having jurisdiction, including any applicable revisions. Any cost in relocation of items due to that subcontractor's error, will be borne by him at no additional cost to the Owner.

G. Where equipment involving more than one subcontractor is installed at a common location and no specific location has been determined, it is the Contractor's responsibility to check with the Architect for the actual rough-in dimensions for such equipment. If for some reason the rough-in has not been checked and a subcontractor has installed his equipment, remaining subcontractors shall align their equipment as closely as possible to the installed equipment. Alignment shall mean centered vertically, equally space and centered horizontally. This alignment applies to bells, alarms, thermostats, switches, handles, access panels, etc. Any items not installed in alignment shall be relocated by the Contractor at his own expense with damaged surfaces properly repaired.

H. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.04 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
   1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
   1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
   2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
   3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.05 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
   4. Maintain minimum headroom clearance of 96 inch in occupied spaces and 90 inch in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.06 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section - Summary.

F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
   5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   6. Proceed with patching after construction operations requiring cutting are complete.

G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      b. Restore damaged pipe covering to its original condition.
   3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
   4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
   5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.07 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
   1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually

agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.08 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
      a. Use containers intended for holding waste materials of type to be stored.
   4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section - Temporary Facilities and Controls.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.09 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 Section - General Commissioning Requirements.

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section - Quality Requirements.

3.10 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

C. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 1 Section - Cutting and Patching.
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

D. Restore permanent facilities used during construction to their specified condition.

E. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

F. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

G. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:
   1. Division 2 Section - Selective Demolition for demolition of selected portions of the building for alterations.
   2. Divisions 2 through 48 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
      a. Requirements in this Section apply to mechanical and electrical installations. Refer to Divisions 21, 22, 23, 25, 26, 27 and 28 Sections for other requirements and limitations applicable to cutting and patching plumbing, mechanical and electrical installations.

1.03 DEFINITIONS

A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.04 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   3. Products: List products to be used and firms or entities that will perform the Work.
   4. Dates: Indicate when cutting and patching will be performed.
   5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
   6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.05 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
   1. Primary operational systems and equipment.
   2. Air or smoke barriers.
   3. Fire-protection systems.
   4. Control systems.
   5. Communication systems.
   6. Conveying systems.
   7. Electrical wiring systems.
   8. Operating systems of special construction in Division 13 Sections.

C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
   1. Water, moisture, or vapor barriers.
   2. Membranes and flashings.
   3. Exterior curtain-wall construction.
   4. Equipment supports.
   5. Piping, ductwork, vessels, and equipment.
   6. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1.06 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Comply with requirements specified in other Sections of these Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.03 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   3. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   4. Excavating and Backfilling: Comply with requirements in applicable Division 31, 32 & 33 Sections where required by cutting and patching operations.
   5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

END OF SECTION 01 73 29

SECTION 01 74 23 - FINAL CLEANUP

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the final cleanup and seeding requirements before the project is turned over to the Owner. For project areas within Texas Department of Transportation (TxDOT) rights-of-way, establish vegetation in accordance with TxDOT requirements if those requirements are more stringent than the requirements of this section.

1.02 RELATED SECTIONS

A. Section 32 92 19 – Seeding

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 PROJECT / SITE CONDITIONS

A. Final grading shall be completed as shown on the Drawings if a grading plan is included.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Project Site. Following the completion of all construction, all debris, surplus materials, and equipment shall be removed from the site. The site shall be fine graded to provide proper drainage from all structures and from the site. When a grading plan is provided, grade the site in accordance with the grading plan. When completed, the entire area shall properly drain and shall be left in a smooth condition, suitable for mowing with standard mowing equipment.

B. Seeding. Seeding for areas other than TxDOT right-of-way shall be in accordance with the seeding specification. Establishment of vegetation in TxDOT right-of-way shall be in accordance with TxDOT requirements if those requirements are more stringent than the requirements of this section of the specifications.

C. Surface. All concrete, steel, and equipment surfaces shall be cleaned.

END OF SECTION 01 74 23

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final completion procedures.
   3. Warranties.
   4. Final cleaning.
   5. Repair of the Work.

B. Related Requirements:
   1. Division 01 Section - Photographic Documentation for submitting final completion construction photographic documentation.
   2. Division 01 Section - Execution Requirements for progress cleaning of Project site.
   3. Division 01 Section - Operation and Maintenance Data for operation and maintenance manual requirements.
   4. Division 01 Section - Project Record Documents for submitting record Drawings, record Specifications, and record Product Data.
   5. Division 01 Section - Demonstration and Training for requirements for instructing Owner's personnel.
   6. Divisions 02 through 33 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.03 ACTION SUBMITTALS

A. Product Data: For cleaning agents.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.04 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.06 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, and similar final record information.
   3. Submit closeout submittals specified in individual Divisions 02 through 33 Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Submit maintenance material submittals specified in individual Divisions 02 through 33 Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.
   5. Submit test/adjust/balance records.
   6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Advise Owner of pending insurance changeover requirements.
   2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   3. Complete startup and testing of systems and equipment.
   4. Perform preventive maintenance on equipment used prior to Substantial Completion.
   5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
   6. Advise Owner of changeover in heat and other utilities.
   7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
   8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   9. Complete final cleaning requirements, including touchup painting.
   10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for final completion.

1.07 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
   1. Submit a final Application for Payment according to Division 01 Section - Payment Procedures.
   2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.08 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
   1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Architect.
      d. Name of Contractor.
      e. Page number.
   4. Submit list of incomplete items in the following format:
      a. PDF electronic file. Architect will return annotated file.

1.09 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within [**15**] <**Insert number**> days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize entire collection of approved warranty documents into an orderly sequence based on the table of contents of Project Manual, with tabs between CSI division sections; i.e.; group all Division-7 building components under one tab, group all Division-8 components under another tab, etc.. Utilize CSI specification sections 2 through 33 for each division tab. Provide **three** copies of each Final Warranty binder.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide title page, Contractor's general One-Year Warranty (corrective period) with agreed upon date and signature of authorized representative, table of contents, and subcontractor list at the beginning of each binder.
3. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
4. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
5. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

D. Provide additional copies of each warranty to include in operation and maintenance manuals. Such copies shall be identical to the warranties included in the warranty binders, but may be photocopies including for warranties that require wet signatures for the original actuated copies.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
g. Sweep concrete floors broom clean in unoccupied spaces.
h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
j. Remove labels that are not permanent.
k. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
l. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
m. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
n. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
p. Leave Project clean and ready for occupancy.

3.02 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
   1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
   2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
      a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
   3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
   4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

01 77 00A - SUBSTANTIAL COMPLETION READINESS CHECKLIST

Substantial Completion means the date determined and certified by the Contractor, Architect, and Owner when the Work, or a designated portion thereof, is sufficiently complete, in accordance with the Contract, so as to be operational and fit for the use intended. When requesting Architect's Inspection for Substantial Completion, the Contractor shall provide not less than 7 working days advance notice to the Architect and Owner (unless otherwise mutually agreed). Contractor shall submit the following checklist indicating readiness for the Inspection, and all accompanying documentation indicated, not less than 7 days prior to the requested date for Architect's inspection for Substantial Completion. Fill out form completely, including comments indicating reasons for incomplete items and anticipated completion as applicable. Architect will provide editable version upon request. Deficiencies in one or more items does not necessarily indicate that project is not ready for inspection. Deficiencies shall be reflected in Contractor's punch list. The Architect's inspection for substantial completion shall not be scheduled on a day when fire alarm testing or other extremely noisy construction activities are scheduled.

Item	Y	N	N/A	Documents / Actions Required
1				**Contractor's Punch List (and Habitual Punch List Items Checked)** *Submit Contractor's Punch List, noting all remaining work items with date scheduled for completion or correction. Contractor shall update and submit / re-submit list as applicable minimum of 2 days and maximum of 5 days prior to the requested date for Architect's Inspection, noting items contractor has corrected and that are still pending. Additionally, Contractor shall field verify the following habitual check list items in preparing the Contractor's Punch List, and indicate that they have been verified by the checklist below:*
	Comments:			
				Confirm there are no outstanding items on the Contractor's Punch List that would adversely affect the Owner's beneficial occupancy.
	Comments:			
				Confirm that all outstanding items on Contractor's Punch List can be completed, and are scheduled for completion, within a maximum of 30 calendar days, or other duration as allowed by the Contract Documents or mutually agreed between Contractor, Architect, and Owner.
	Comments:			
				The area of the Facility included in the Contractor's Work has been, or will be by the requested date, completely cleaned and ready for Architect's Inspection.
	Comments:			
				Temporary Facilities have been removed, or will be removed, by requested date of Inspection (except for any items otherwise mutually agreed to remain after the date of Owner's beneficial occupancy).
	Comments:			
				All paving sealants installed, and zip strips removed where applicable.
	Comments:			
				All millwork / cabinets checked that all hardware is installed. Doors, drawers and moving parts checked for smooth operation through full range of motion. Hinges adjusted for alignment of adjacent doors.
	Comments:			

				Remove loose fasteners and debris from roofs, parking lot, and site.
	Comments:			
				All door and window hardware installed by Contractor checked for missing items.
	Comments:			
				All operable windows checked for smooth operation through full range of movement. Locking devices all aligned and properly engage. Screens installed where applicable.
	Comments:			
				All door silencers in place. Soiled / painted silencers replaced with new.
	Comments:			
				All doors / hardware installed by Contractor checked for proper operation. *This includes but is not limited to: Proper latching and locking operation, doors not binding on hinges or in door frames, closers and pivots adjusted to self-close and latch, and to operate in compliance with Texas Accessibility Standards, hold-opens verified adjusted for operation and release, hold-open function in closers tested where applicable, flush bolts throw fully into frames and floors, and proper operation of electronic hardware. Contractor's final submission of Contractor's punch list prior to Inspection shall include any observed deficiencies.*
	Comments:			
				All overhead doors and other mechanically operated doors, thoroughly checked for proper adjustment and operation of all control functions, binding in tracks, and any other deficiencies. Corrections made as required.
	Comments:			
				Check all ceiling tile for nicks, stains, and other damage, and replace with new as required. Check new ceiling grid for warp and damage and repair as required. Verify all tile is seated in the grid.
	Comments:			
				All interior finishes work complete and ready for Architect's inspection (other than minor touch-up).
	Comments:			
				All interior signage installed and accounted for.
	Comments:			
				All equipment and appliances installed by Contractor tested for proper adjustment and operation.
	Comments:			
				All pipes labeled as required by Contract Documents.
	Comments:			
				All exposed pipe penetrations checked for sealants (fire sealant where applicable), and escutcheons, as required by Contract Documents.
	Comments:			

				Remove all faucet aerators, flush lines of dirt, sand, and debris, and reinstall aerators. Test all faucet handles for correct hot and cold line connection / control.
	Comments:			
				Water closets and urinal fixtures tested for proper flush operation.
	Comments:			
				HVAC is functioning and humidity control is acceptable.
	Comments:			
				Fans operating correctly including their controls.
	Comments:			
				HVAC Filters to be replaced just prior to substantial completion with new filters.
	Comments:			
				HVAC ducts checked for construction dust and debris contamination and cleaned as applicable in compliance with requirements of the Contract Documents.
	Comments:			
				Electrical panels / schedules completely filled out and labeled, in compliance with Contract Documents. (*And other devices and circuits labeled where required by Contract Documents*)
	Comments:			
				Check all open electrical boxes have cover plates and screws, and painted where applicable.
	Comments:			
				Test all power outlets and switches.
	Comments:			
				Test all data outlets (if installed by this Contract)
	Comments:			
				Verify water heaters are installed with proper disconnects.
	Comments:			
				All lighting and lighting control systems have been tested for proper operation. Vacancy and occupancy sensors adjusted to proper duration and tested for sensitivity. Debug / repair as required. Replace burned out or inoperable lamps / modules as required by Contract Documents.
	Comments:			
				All landscaping, turf, and irrigation (*or temporary irrigation as applicable*) has been or will be installed / seeded by the requested date for Architect's inspection. *(Except as otherwise agreed or otherwise required due to planting season Note any pending installation on Contractor's punch list.)*
	Comments:			

2				**Final Inspections** All required final inspections have or will be passed by date of substantial completion (local and State). *Or, if any will be remaining the status will not affect Owner's beneficial occupancy and has been agreed to be acceptable by Owner.*
	Comments:			
3				**Certificate of Occupancy** A Certificate of Occupancy has been or will be issued by the requested date for inspection. *Or if not, a Temporary Certificate of Occupancy has been issued, and any outstanding items will not affect beneficial occupancy and are scheduled for correction and final inspection within 30 days or less.*
	Comments:			
4				**Owner Notification** Owner has been notified by Contractor with adequate time of pending changeover in utilities, insurance and building and site security, in accordance with the Contract Documents.
	Comments:			
5				**Extra Materials** All extra materials, attic stock, and maintenance tools required by the construction documents to be provided by Contractor have been delivered to Owner (submit transmittals indicating each item, quantities and receipt). *Any outstanding extra materials not yet delivered are acceptable to Owner for beneficial occupancy and are noted in Contractor's punch list, with anticipated delivery dates*.
	Comments:			
6				**Final Keying** Final key cores and keys as applicable to project scope have or will be installed, or have been delivered Owner's installer, in time for the requested date of substantial completion. This includes all keys for any locking cabinets, lockers, toilet accessories, etc. as applicable.
	Comments:			
7				**Security and Access Control** Applicable intrusion detection, security camera, access control, gate operators, and similar systems required for access and security are or will be operational in time for requested date for substantial completion. *(Where these systems are not the installed as part of this contract, Contractor has made due effort to coordinate with Owner's separate contract or vendor for timely completion).*
	Comments:			
8				**Owner Training** All Owner training required by the Contract Documents has been scheduled with Owner, or Owner Training Conference has been conducted and Owner has agreed that any training that will not be performed by the date of substantial completion is acceptable for beneficial occupancy.
	Comments:			

9				**Testing and Balancing Report** A copy of the initial HVAC testing and balancing report has been submitted to the Architect. *Any deficiencies are included in Contractor's punch list, and corrections and re-testing scheduled within the allowable duration for Final Completion.*
	Comments:			
10				**Record Drawings** To the best of Contractor's knowledge, annotations on record drawings are up to date. Preliminary review copy of marked up Record Drawings has been or will be submitted to Architect for review prior to the requested date for inspection.
	Comments:			
11				**Operations and Maintenance Manuals** Preliminary review copy of O&M binders has been or will be submitted to Architect for review prior to the requested date for inspection.
	Comments:			
12				**Record Submittals / Product Data** Preliminary review copy of project Record Submittals (if required) has been or will be submitted to Architect for review prior to the requested date for inspection.
	Comments:			
13				**Warranties Binder** Preliminary review copy of warranties binder has been or will be submitted to Architect for review prior to the requested date for inspection.
	Comments:			
14				**Roofing Manufacturer's Warranty Inspection** Roofing manufacturer's inspection has been performed and Roof Warranty has been achieved by requested date for inspection. *Or if warranty is not achieved, only minor corrections remain to achieve warranty, and submit Manufacturer's deficiency list/report with Contractor's punch list.*
	Comments:			

END OF SECTION 01 77 00A

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Emergency manuals.
   3. Operation manuals for systems, subsystems, and equipment.
   4. Product maintenance manuals.
   5. Systems and equipment maintenance manuals.

B. Related Requirements:
   1. Division 01 Section - Submittal Procedures for submitting copies of submittals for operation and maintenance manuals.
   2. Divisions 02 through 33 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.03 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.04 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:
   1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
      a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
      b. Enable inserted reviewer comments on draft submittals.
   2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training.

1. Correct or revise each manual to comply with Architect's comments. Submit three Final copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.01 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.02 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.
   3. Subcontractor list
   4. Manual contents.

B. Title Page: Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name and contact information for Contractor.
   6. Name and contact information for Construction Manager.
   7. Name and contact information for Architect.
   8. Name and contact information for Commissioning Authority.
   9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
   10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Subcontractor List: Organize subcontractor list by CSI specification section, as listed in the Project Manual table of contents. Provide contact name, street address (no P.O. Box numbers) and contact phone and fax number. If changes were made during the course of the project, utilize final contract company for each component of the work. List all contractors used on project, even if subcontracted to a different subcontractor, i.e; if earthwork subcontractor is contracted by the paving subcontractor, list both subcontractors.

E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
   1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
   1. Binders: Heavy-duty, three-ring, vinyl-covered binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
   2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
   4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
   5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.03 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.
   3. Gas leak.
   4. Water leak.
   5. Power failure.
   6. Water outage.
   7. System, subsystem, or equipment failure.
   8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.
   4. Required sequences for electric or electronic systems.
   5. Special operating instructions and procedures.

2.04 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
   2. Performance and design criteria if Contractor has delegated design responsibility.
   3. Operating standards.
   4. Operating procedures.
   5. Operating logs.
   6. Wiring diagrams.
   7. Control diagrams.
   8. Piped system diagrams.
   9. Precautions against improper use.
   10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:
   1. Product name and model number. Use designations for products indicated on Contract Documents.
   2. Manufacturer's name.
   3. Equipment identification with serial number of each component.
   4. Equipment function.

5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.05 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:
1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Bonds: Include copies of bonds and lists of circumstances and conditions that would affect validity of bonds.
1. Include procedures to follow and required notifications for warranty claims.

2.06 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard maintenance instructions and bulletins.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

PART 3 - EXECUTION

3.01 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
   1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
   1. Do not use original project record documents as part of operation and maintenance manuals.
   2. Comply with requirements of newly prepared record Drawings in Division 01 Section - Project Record Documents.

G. Comply with Division 01 Section - Closeout Procedures for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.
   4. Miscellaneous record submittals.

B. Related Requirements:
   1. Division 01 Section - Closeout Procedures for general closeout procedures.
   2. Division 01 Section - Operation and Maintenance Data for operation and maintenance manual requirements.
   3. Divisions 02 through 33 Sections for specific requirements for project record documents of the Work in those Sections.

1.03 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set of marked-up record prints.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
   1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

2.01 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
   1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an acceptable drawing technique.
      c. Record data as soon as possible after obtaining it.

d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:
   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Depths of foundations below first floor.
   d. Locations and depths of underground utilities.
   e. Revisions to routing of piping and conduits.
   f. Revisions to electrical circuitry.
   g. Actual equipment locations.
   h. Duct size and routing.
   i. Locations of concealed internal utilities.
   j. Changes made by Change Order or [Construction] [Work] Change Directive.
   k. Changes made following Architect's written orders.
   l. Details not on the original Contract Drawings.
   m. Field records for variable and concealed conditions.
   n. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
   1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
   2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
   2. Format: Annotated PDF electronic file [with comment function enabled].
   3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
   4. Identification: As follows:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of Architect.
      e. Name of Contractor.

2.02 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
   3. Record the name of manufacturer, supplier, installer, and other information necessary to provide a record of selections made.
   4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
   5. Note related Change Orders and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

2.03 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
   3. Note related Change Orders, record Specifications and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file.
   1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

PART 3 - EXECUTION

3.01 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.

B. Related Requirements:
   1. Divisions 02 through 33 Sections for specific requirements for demonstration and training for products in those Sections.

1.03 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.04 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.01 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
   1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
      a. System, subsystem, and equipment descriptions.
      b. Performance and design criteria if Contractor is delegated design responsibility.
      c. Operating standards.
      d. Regulatory requirements.
      e. Equipment function.
      f. Operating characteristics.
      g. Limiting conditions.
      h. Performance curves.
   2. Documentation: Review the following items in detail:
      a. Emergency manuals.
      b. Operations manuals.
      c. Maintenance manuals.
      d. Project record documents.
      e. Identification systems.
      f. Warranties and bonds.
      g. Maintenance service agreements and similar continuing commitments.
   3. Emergencies: Include the following, as applicable:
      a. Instructions on meaning of warnings, trouble indications, and error messages.
      b. Instructions on stopping.
      c. Shutdown instructions for each type of emergency.
      d. Operating instructions for conditions outside of normal operating limits.
      e. Sequences for electric or electronic systems.
      f. Special operating instructions and procedures.
   4. Operations: Include the following, as applicable:
      a. Startup procedures.
      b. Equipment or system break-in procedures.
      c. Routine and normal operating instructions.
      d. Regulation and control procedures.
      e. Control sequences.
      f. Safety procedures.
      g. Instructions on stopping.
      h. Normal shutdown instructions.
      i. Operating procedures for emergencies.
      j. Operating procedures for system, subsystem, or equipment failure.
      k. Seasonal and weekend operating instructions.
      l. Required sequences for electric or electronic systems.
      m. Special operating instructions and procedures.
   5. Adjustments: Include the following:
      a. Alignments.
      b. Checking adjustments.
      c. Noise and vibration adjustments.
      d. Economy and efficiency adjustments.
   6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.
8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.01 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data."

B. Set up instructional equipment at instruction location.

3.02 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
   2. Owner will furnish an instructor to describe Owner's operational philosophy.
   3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
   1. Schedule training with Owner with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 01 79 00

SECTION 02 41 16 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Demolition and removal of buildings and site improvements.
   2. Abandoning in-place or Removing below-grade construction.
   3. Disconnecting, capping or sealing, and abandoning in-place or removing site utilities.
   4. Salvaging items for reuse by Owner.

B. Related Sections:
   1. Division 01 - Section Summary for use of the premises and phasing requirements.
   2. Division 01 Section - Construction Progress Documentation for preconstruction photographs taken before building demolition.
   3. Division 23 Sections for demolishing or relocating site mechanical items.
   4. Division 31 Section - Site Clearing for site clearing and removal of above- and below-grade site improvements not part of building demolition.
   5. Division 33 Section - Common Work Results for Utilities for shutting off, disconnecting, removing, and sealing or capping utilities.

1.03 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

1.04 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified refrigerant recovery technician.

B. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property**,** for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Building Demolition Activities: Indicate the following:
   1. Detailed sequence of demolition work, with starting and ending dates for each activity.
   2. Temporary interruption of utility services.
   3. Shutoff and capping or re-routing of utility services.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

E. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Division 01 Section - Photographic Documentation. Submit before the Work begins.

F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

G. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.06 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

D. Predemolition Conference: Conduct conference at Project site prior to demolition work.
   1. Inspect and discuss condition of construction to be demolished.
   2. Review structural load limitations of existing structures.
   3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review and finalize protection requirements.
   5. Review procedures for noise control.
   6. Review procedures for protection of adjacent buildings.
   7. Review items to be salvaged and returned to Owner.

1.07 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
   1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
   2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
      a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. Owner assumes no responsibility for buildings and structures to be demolished.
   1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   2. Before building demolition, Owner/Others will remove the following items:
      a. As indicated in drawings.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
3. Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.

F. On-site storage or sale of removed items or materials is not permitted.

PART 2 - PRODUCTS[(Not Used)**]**

2.01 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Division 31 Section - Earth Moving.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Steel Tendons: If tensioned steel tendons are located, engage professional engineer to include recommendations for de-tensioning.

C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.02 PREPARATION

A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.

B. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
4. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

C. Existing Utilities: See Divisions 22 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

D. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of demolition.

3.03 PROTECTION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
   1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
   2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
      a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 01 Section - Temporary Facilities And Controls.
   1. Protect adjacent buildings and facilities from damage due to demolition activities.
   2. Protect existing site improvements, appurtenances, and landscaping to remain.
   3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
   4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
   6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
   7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.04 DEMOLITION, GENERAL

A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
   2. Maintain fire watch during and for at least 2 hours after flame cutting operations.
   3. Maintain adequate ventilation when using cutting torches.
   4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.

C. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

D. Explosives: Use of explosives is not permitted.

3.05 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
   2. Doors and door hardware.
   3. Windows.
   4. Cabinets.
   5. Mirrors.
   6. Chalkboards.
   7. Tackboards.
   8. Marker boards.
   9. Plumbing fixtures.

C. Below-Grade Construction: Demolish foundation walls and other below-grade construction.
   1. Remove below-grade construction, including basements, foundation walls, and footings, completely.

D. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet outside footprint indicated for new construction. Abandon utilities outside this area.
   1. Fill abandoned utility structures with satisfactory soil materials according to backfill requirements in Division 31 Section - Earth Moving.

3.06 DEMOLITION BY EXPLOSIVES

A. Explosives: Perform explosive demolition according to governing regulations.
   1. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
   2. Do not damage adjacent structures, property, or site improvements when using explosives.

B. Comply with recommendation in specialty explosives consultant's report.

3.07 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.08 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.09 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction. See Division 01 Section - Construction Waste Management and Disposal for recycling and disposal of demolition waste.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.10 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
   1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16

SECTION 02 80 00 - HAZARDOUS MATERIAL ABATEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections:
   1. Divion 0 – "Information Available to Proposers"

1.02 SCOPE OF WORK

A. Provide all operations required in connection with the removal of asbestos containing materials in renovated areas, including the removal and proper disposal of all existing and generated trash from demolition and abatement, whether or not identified in the Asbestos Inspection Report described in Division 1 Section - Information Available to Bidders.

1.03 EXAMINATION OF SITE

A. Contractor shall visit and examine the building and site to ascertain the actual nature and scope of demolition work. Later claims for additional compensation covering difficulties encountered in demolition work will not be recognized.

1.04 GENERAL REQUIREMENTS

A. Comply with all applicable federal, state and local codes and ordinances and with the requirements of insurance carriers providing coverage for this work.

B. Comply with all Texas Department of Health (TDH) and EPA notification requirements.

C. Removal of existing resilient floor coverings and adhesives shall comply with the work practices recommended by the Resilient Floor Covering Institute's "Recommended Work Practices for the Removal of Resilient Floor Coverings" dated August, 1995. In addition, asbestos-containing flooring materials shall be removed in compliance with the same RFCI recommendations, and OSHA, EPA and any state and local standards or requirements.

D. Contractor shall provide to the Owner at the pre-construction conference documentation confirming abatement contractor and all workmen involved with the demolition have received required training and licensing, as per TDH, EPA, RFCI, and OSHA requirements.

E. Procure and pay for all permits or certificates required for the work involved.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 PROTECTION OF EXISTING FACILITIES

A. The Contractor shall take all necessary precautions to insure against damage to existing work to remain in place, and any damage to such work shall be repaired or replaced as approved by the Architect at no additional cost to the Owner.

3.02 ABATEMENT

A. A pre-demolition asbestos survey was conducted, the results of which are incorporated herein. Contractor shall determine extent of work required and execute the necessary work, in a manner compliant with Authorities having jurisdiction, to address the following materials as applicable:
   1. Transite pipe.
   2. Ceiling tile and mastic.
   3. Vinyl floor tile and mastic.
   4. Drywall textures/wallcovering.
   5. Any other material as identified in Survey.

B. Before commencing general demolition activities, Federal and State law requires that all asbestos-containing materials that could possibly be disturbed during such activities be abated. It has been determined that the necessary work will disturb the known asbestos-containing building materials (ACBM). Therefore, the General Contractor is required to secure the necessary services of a Texas Licensed Asbestos Consultant and a Texas Licensed Asbestos Abatement Contractor to affect removal of the aforementioned ACBM prior to initiating any work at the Subject Property that could possibly disturb any of the ACBM.

C. It is the responsibility of the General Contractor to determine and certify that all asbestos-related work is performed by properly licensed, trained and experienced personnel, and that all work pertaining to the removal of ACBM meet all applicable requirements of:
   1. Texas Asbestos Health Protection Rules, Sections 295.31 through 295.73, March 2003.
   2. The National Emission Standard for Hazardous Pollutants (NESHAP), Asbestos Regulations (40 CFR 61, Subpart M).
   3. Applicable regulations of the Occupational Safety and Health Administration (OSHA), including 29 CFR 1910.134 and 29 CFR 1926.
   4. AHERA Regulations 40 CFR Part 763, Subpart E, Appendix C, as it applies to accreditation of asbestos abatement contractor personnel.

D. The required third party air quality monitoring shall be commissioned and paid for by the Contractor.

3.03 DEMOLITION

A. Existing finish flooring, including mastic, shall be completely removed and the substrate prepared to receive the new flooring.

B. Erect necessary barricades and protective measures as required.

3.04 DISPOSAL

A. Except as otherwise provided, all items demolished or cleared from the building resulting from the work of this section shall be removed and disposed of off-site in a TDH/EPA approved disposal site with a documented manifest provided to the Owner at project close-out.

END OF SECTION 02 80 00

SECTION 03 10 00 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Forming all flatwork
   2. Forming building pad.

B. Related Sections include the following:
   1. Division 03 Section “Concrete Reinforcement.”
   2. Division 03 Section “Cast-in-Place Concrete.”

1.03 SUBMITTALS

A. Submit diagrams of proposed construction joints not shown on the drawings for approval by the Engineer.

1.04 QUALITY ASSURANCE

A. American Concrete Institute Standard ACI 347, "Recommended Practice for Concrete Formwork".

PART 2 - PRODUCTS

2.01 MATERIALS

A. Forms:
   1. Wood forms for unexposed concrete surfaces shall be built of sufficient thickness to sustain the loads to be imposed thereon, dressed to uniformly smooth contact surfaces, and so constructed as to be readily removable.
   2. Wood forms for exposed concrete surfaces shall be constructed of commercial standard Douglas Fir, moisture-resistant, concrete form plywood not less than 5-ply, and at least 9/16" thick, with one smooth face, or shall be forms with linings of one of the following types:
      a. Plywood: Commercial standard Douglas Fir, concrete form, exterior 3-ply, not less than 1/4" thick, having one smooth face or,

b. Fiberboard: Treated, hard-pressed box forms, in size indicated on drawings and as manufactured by National Container Corporation or approved equal, and rated to sustain a load exceeding the total weight of fresh concrete placed over the voids.

PART 3 - EXECUTION

3.01 GENERAL

A. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. Adequately shore all concrete members to safely support all loads and lateral pressures outlined in "Recommended Practice for Concrete Formwork" (ACI 347) without distortion, excessive deflection or other damage. Build all necessary forms centering, shores and moulds to conform to the shapes, lines and dimensions of the various members of concrete construction lines, and dimensions of the various members of the concrete construction as shown or scheduled on the drawings. Construct sufficiently tight and so substantially assembled as to prevent bulging or leakage of mortar. Assemble forms to be readily removable without impact, shock or damage to the concrete. Provide temporary openings as required to facilitate cleaning, drainage and inspection. Clean all contact surfaces of lumber once used as forms thoroughly before reuse.

B. Install form ties at proper intervals to securely hold the forms in position during the placing of concrete, and to withstand the weight and pressure of the wet concrete. Coat ties of a type intended to be entirely removed with an approved lubricant to safeguard against damaging the concrete during removal. The use of wire ties will not be permitted.

C. Place and anchor in the forms wood strips, blocking, mouldings, nailers, etc., required to produce the finished profiles and surfaces shown on the drawings and to provide nailing for wood members or other features required to be attached to concrete surfaces in such manner. Coat wood strips, blocking and mouldings with form sealer.

D. Special care shall be given to formwork, ties, bracing, etc. for any concrete surface to be left exposed to permanent view. Waves, bulges, form marks, staining, joint marks or irregularities will not be tolerated and shall be considered unacceptable.

3.02 CONSTRUCTION JOINTS

A. Should construction joints prove to be absolutely unavoidable, locate such joints within the middle third of spans or as detailed on the drawings. Make no additional construction joints under any circumstances without the written approval of the Architect.

B. Provide appropriate keys in all construction joints, whether horizontal or vertical.

3.03 MISCELLANEOUS

A. Construction forms shall be provided for any and all items of concrete work required for or in connection with the satisfactory completion of the project, whether each such item is specifically shown or referred to or not.

3.04 SLABS

A. Form all openings in concrete slabs as required for the vertical passage of ducts, pipes, conduits, etc..

3.05 REMOVAL OF FORMS

A. Do not remove forms until concrete is adequately hardened and set. Clamps or tie rods may be loosened 24 hours after concrete is placed; ties, except for a sufficient number to hold the forms in place, may be removed at that time.

B. Form removal shall be accomplished as a hand operation, with due care to avoid damage to any finished concrete work or any reinforcing passing through forms being removed.

C. Proper cold weather curing procedures shall be observed if concrete forms are removed when the temperature is below 40 degrees F. Refer to recommendations that are set forth in "Recommended Practice for Cold Weather Concreting" (ACI 306).

3.06 CLEANING

A. Upon completion of work of this section, remove related debris from job site.

END OF SECTION 03 10 00

SECTION 03 11 14 - SITE CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SUMMARY

A. This section defines the requirements and limitations for the design, construction, erection, and removal of concrete formwork.

1.02 RELATED SECTIONS

A. Section 03 30 54 – SITE CAST-IN-PLACE CONCRETE

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ACI 347-American Concrete Institute, " Recommended Practice for Concrete Formwork."

1.05 SYSTEM DESCRIPTION

A. All formwork shall be designed for the loads, lateral pressure, and allowable stresses described in the reference standard (ACI 347) and the applicable requirements of local building codes. The maximum allowable deflection for concrete surfaces exposed to view is 1/240 of the span between structural members.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Forms. Full size, moisture resistant, three-fourths (3/4) inch thick, 5-ply Douglas fir form plywood shall be used as form lumber. Joints in forms shall be horizontal or vertical. Metal or other types of forms are allowed only with the prior approval of the Engineer and shall produce surfaces equal to those by the specified wood forms.

1. Exposed Surfaces. Form lumber for exposed surfaces shall meet the above size and type requirements and be faced Grade B, or better, plywood. Do not use material with raised grain, torn surfaces, patches, dents, warps, knots, or other defects.
2. Unexposed Surfaces. Undressed lumber may be used for forming unexposed surfaces.

B. Form Ties. Form ties for exposed surfaces shall be threaded rod type or snap ties and shall be of sufficient strength to withstand the pressure resulting from the placement of the concrete. Threaded rod type form ties shall be at least one and one-half (1-1/2) inches shorter than the wall thickness. Form ties shall be such that when forms are removed, no metal is closer that three-quarters (3/4) inch from the surface and shall leave a small, clean hole to be grouted. Securing forms with wire is strictly prohibited.

C. Form Coating. Use commercial formulation of form oil or form-release agent having proven satisfactory performance. Coating must not bond with, stain, or adversely effect the concrete surfaces and shall not impair the use of bonding agents and curing compounds. If form oil is used, all excess oil shall be wiped off leaving the surface just oily to the touch.

D. Chamfer Strips. Provide chamfer strips in corners of forms to produce beveled edges on permanently exposed surfaces. Size of chamfer shall be three-quarters (3/4) inch unless shown otherwise on the Drawings. Interior corners and edges of formed joints do not require any beveling unless shown otherwise on the Drawings.

E. Earth Cuts for Forms. Use earth cut forms for beams under slabs on grade when the beam has sloped sides and is integral with the slab. Earth cut forms are allowable for sides of footings if the sides of the excavation are stable such that there is no caving or sloughing.

F. Slip Forms. Slip forming is not permitted.

PART 3 - EXECUTION

3.01 PREPARATION

A. General. At least 24 hours prior to scheduled concrete placement, notify the Engineer that formwork may be observed. Do not place concrete until forms have been observed by the Engineer.

B. Preparation of Form Surfaces. Clean all surfaces of forms and embedded objects before placement of concrete. Remove accumulated mortar, grout, rust, debris

and any other foreign material. Coat forms for exposed or painted surfaces with form oil or other form-release agent before placing concrete. Form oil, or other form-release agent, shall be used in strict accordance with the manufacturer's printed instructions. Do not allow excess form coating material to accumulate in forms or come in to contact with previously placed hardened concrete against which fresh concrete will be placed. No form coating material shall be placed on the reinforcement. Other than retained-in-place metal forms, forms for unexposed concrete surfaces may be wetted with water immediately prior to placement of concrete in lieu of using a form coating material. Such wetting of forms with water is not allowed when the possibility of freezing temperatures exists.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. General. Construct forms to the shape, lines and dimensions of the members as shown on the Drawings. Forms shall be sufficiently tight to prevent the leakage of mortar. Temporary openings shall be provided at the base of column and wall forms or at other required points to facilitate the cleaning and inspection immediately before placement of concrete.

B. Facing Material. Facing material for exposed surfaces shall be placed in an orderly and symmetrical fashion. Full size pieces shall be used except where small pieces will cover an entire area. Facing material shall be adequately supported to prevent deflection. Facing material for exposed surfaces shall be installed in such a manner that will allow the Engineer access to observe the exposed surface forms before the back form is in place.

C. Bracing of Forms. Anchor, brace, and tie all formwork to shores, members, or other supporting surfaces to prevent the upward movement of the forms during the placement of concrete. Tighten forms to close joints and provide conformance to the specified lines and shapes. All forms that cannot be properly tightened shall be removed and rebuilt. All forms shall be securely braced to prevent lateral deflections during placement of concrete. Use wedges or jacks to provide positive adjustment of shores and struts. For wall openings, construct wood forms that facilitate loosening to counteract swelling of forms.

D. Shoring of Forms. When shoring is permitted or required, construction shall follow a planned sequenced. Such plan shall be provided by the Contractor prior to construction.

E. Removal of Forms. Forms for structural slabs and beam bottoms shall remain in place for a period of fourteen (14) days or until cylinder tests have shown that the concrete has reached eighty (80) percent of 28-day design strength as evidenced by laboratory test reports. In no case shall forms be removed in less than four (4) days.

F. Form Reuse. Do not reuse forms that are worn or damaged beyond repair.

Thoroughly clean and recoat forms before reuse. For wood forms to be used for exposed surfaces, sand or otherwise dress the surface to be in contact with the concrete to the original condition or provide form liner facing material. Before reusing metal forms, straighten, remove dents and clean such that the forms are returned to original condition.

END OF SECTION 03 11 14

SECTION 03 15 17 - SITE CONCRETE JOINTS AND EMBEDDED ITEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies requirements for construction joints, expansion joints and embedded items for concrete. Review drawings and specifications for additional requirements for joints and embedded items.

1.02 RELATED SECTIONS

A. Section 03 30 54 – Site Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. American Society for Testing and Materials (ASTM).
   2. ASTM A-120, "Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses."
   3. ASTM A--306, "Carbon Steel Bars Subject to Mechanical Property Requirements."
   4. ASTM D-994, "Preformed Expansion Joint Filler for Concrete (Bituminous Type)."
   5. ASTM D-1751, "Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextending and Resilient Bituminous Types).
   6. ASTM D-1752, "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Expansion Joint Filler. Use 3/4-inch thick asphalt impregnated fiberboard or redwood in accordance with ASTM D-1751.

B. Expansion Joint Sealer. Use joint sealing compound conforming to ASTM C920,

Type S, Grade P or NS.

C. Expansion Joint Dowels. Use plain steel bars conforming to ASTM A-306, grade 70. Cut Dowels to length at shop or mill before delivery to the site. Dowels must be straight and clean, free of rust and scale.

D. Sleeves. Provide sleeves which are 26-gauge steel or PVC tubes and are capped at one end. Sleeves shall be in accordance with ASTM A-120.

E. Waterstops. Unless otherwise shown on the plan details waterstops shall be polyvinylchloride and be Seal-Tight, Type No. 6DS, as manufactured by W.R. Meadows, Inc.; Type No. 6, wide flange (PVC), as manufactured by Duro-Wal; Type CB 1-1/8, as manufactured by Williams Products; or a preapproved equal.

PART 3 - EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. General. Place embedded items as shown on the plan details and in such a manner that will not impair the strength of the structure. Should locations of embedded items conflict with reinforcement or be detrimental to strength of the structure, notify the Engineer so the items can be relocated. Notification shall be such that the scheduled concrete placement is not delayed and there is adequate time to relocate the embedded items. Adequately secure all embedded items to prevent displacement during concrete placement.

B. Conflicts with Reinforcement. Do not cut or reposition reinforcing steel to facilitate the installation of inserts, conduits, sleeves, anchor bolts, mechanical openings and similar items without the prior knowledge of the Engineer.

C. Construction Joints. Make construction joints only at locations shown the plan details or as specified in these specifications. Relocation of construction joints is strictly prohibited without the prior knowledge of the Engineer. Install construction joints in compliance with the following procedures:

1. Locate joints in such a manner that will least impair the strength of the structure being constructed.
2. Place all joints perpendicular to main reinforcement. Reinforcing shall be extended through all joints unless otherwise shown.
3. Prepare joints by removing loosened particles of aggregates or damaged concrete at the surface.
4. Install any joint filler on expansion joints to full depth of the concrete section with the top held down 3/4-inch to provide recess for sealant.

D. Waterstops. Install waterstops in the locations shown and in a manner that will develop effective watertightness. Position and support waterstops against any

displacement during placement of concrete.

END OF SECTION 03 15 17

SECTION 03 20 00 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Includes furnishing all materials, equipment, transportation and facilities and performing all labor necessary for the following:
   1. Prepare shop drawings of reinforcing steel.
   2. Furnish and place reinforcing steel.
   3. Fabrication and installation of embedded metal assemblies.

B. Related Sections include the following:
   1. Division 01 "Quality Requirements."
   2. Division 03 "Concrete Formwork."
   3. Division 03 "Cast-in-Place Concrete."

1.03 SUBMITTALS

A. Shop Drawings: Submit shop and installation drawings of reinforcement and embedded metal assemblies for review by the Engineer. Reproduce the bar bending diagram, the beam, slab and joist notes and cast-in-place concrete notes that concern the proper placing of reinforcing and submit it with each set of shop drawings for field use. Use same bar marks on bar bending diagrams as used on the beam, and slab schedule. Use same beam, and wall marks as Contract Documents.

B. Mill Test Reports: Deliver certified copies, evidencing compliance with all requirements of these specifications to the Engineer with all deliveries of reinforcing steel.

C. Submit copies of laboratory inspection reports as follows:
   Steel Supplier - 1 Copy
   General Contractor - 1 Copy
   Owner - 1 Copy
   Architect - 1 Copy
   Structural Engineer - 1 Copy

1.04 LABORATORY TESTING AND INSPECTION

A. Inspect welding of deformed bar anchors at the beginning of each period of production for size, length and quality. Re-inspect corrected welds.

B. Reinforcing: inspect all reinforcing steel prior to placement of concrete for compliance with the Contract Documents and the approved shop drawings. All instances of noncompliance shall be immediately brought to the attention of the Contractor. If uncorrected by the contractor, they shall be listed in the report.
   1. Observe and report the following: number and size of bars; bending; splicing; clearance to forms; clearance between bars; rust, form oil or other contamination; fabrication and installation of embedded metal assemblies, including visual inspection of all welds.

C. Inspector shall have a minimum of three years experience inspecting reinforcing steel in projects of similar size.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcing: All of domestic manufacturers.
   1. Bars: New deformed billet steel, ASTM A-615, grade 60.
   2. Reinforcing bars to be welded: ASTM A706; Bars shall have a carbon content not exceeding 0.30% and a manganese content not exceeding 0.60%. Provide certified copies of the ladle analysis for each lot of bars to be welded.
   3. Welded Wire Fabric: Not Used
   4. Epoxy coated reinforcing bars: ASTM A775.

B. Fiber reinforcing: Not Used

C. Concrete accessories including bar supports, chairs, spacers, etc.: Cold-drawn wire and fabricated in accordance with the requirements of Chapter Seven of the ACI Standard 315 with heights as required.

D. Bar supports for concrete resting on earth: Precast concrete briquettes having tie wires embedded therein, or individual high chairs No. HCP with welded plates on bottom as manufactured by Hohmann & Barnard, Inc. Provide bar supports, hot-dipped galvanized after fabrication, where concrete will be exposed including ceilings of flat slabs.

2.02 METAL ANCHORAGE & CONFINEMENT ASSEMBLIES

A. Steel Shapes and Plates and Rods: Conform to ASTM A572 Grade 50.

B. Welded Deformed Bar Anchors: Welded by full-fusion process; "Nelson" Anchors Type D2L or approved equal.

C. Headed Stud Anchors: Headed Studs welded by full fusion process as furnished by Nelson Stud Welding Company or approved equal.

D. Bolts: Conform to ASTM F1554 with regular hexagon nuts and carbon steel washers.

E. Straps: Conform to ASTM A245 or A284.

F. Welding Electrodes: ASTM Designation A233, Series E70 - AWS 5.5.

G. Dowels 5/8" smooth x 2'-0" long with sleeves, supports and end caps.

2.03 FABRICATION

A. Fabricate reinforcing steel in compliance with the CRSI "Manual of Standard Practice".

B. All bar splices shall be a minimum of Class "A" lap unless specified otherwise on drawings.

C. Shop-fabricate reinforcing bars to conform to the required shapes and dimensions, with fabrication tolerances complying with ACI 315. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.

D. Deliver all reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

E. Reinforcing with any of the following defects will not be permitted in the work: Bar lengths, depths, and bends exceeding the specified fabrication tolerances, bends or kinks not indicated on drawings or final shop drawings, bars with reduced cross-section due to excessive rusting or other cause.

2.04 COATING

A. Rust inhibitor for field application to metal accessories shall be Hi-Build Epoxoline manufactured by the TNEMEC Co., Kansas City, Missouri or approved equal.

B. Hot dip galvanizing shall conform to ASTM A123.

C. Cold Galvanizing Compound for field repair of galvanizing shall be “ZRC Cold Galvanizing Compound” by ZRC Chemical Products Company, Quincy, Massachusetts, or approved equal.

PART 3 - EXECUTION

3.01 MATERIAL STORAGE

A. Stack reinforcing steel in tiers. Exercise care to maintain all reinforcement free of dirt, mud, paint, rust, etc.

3.02 GENERAL

A. Place reinforcing steel of the sizes, shapes, lengths, spacing and other dimensions where shown on the drawings. Details of reinforcing shall conform to the ACI Building Code Requirements for Structural Concrete (ACI 318-99).

3.03 MARKING

A. Mark bars plainly. Limit bundles to 1 size and 1 length and tag each bundle with metal tags.

3.04 CLEANING

A. Clean reinforcement thoroughly of rust, mill scale, dirt, oil or other coatings which might tend to reduce the bonding to the concrete.

3.05 BENDING

A. Bend bars cold. Heating of reinforcement, or handling by makeshift methods, will not be permitted and bars having kinks or bends not required will be rejected.

3.06 PLACING

A. Comply with the specified codes and standards, and the Concrete Reinforcing Steel Institute recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

B. Place reinforcement accurately, securely saddle tie at every other intersection with No. 18 gauge black annealed wire, and rigidly hold in place during the placing of the concrete by means of metal chairs or spacers.

C. Hold bars in position and to proper clearance of concrete surface by spacers, chairs, or other necessary supports with the following tolerances:
   1. Top bars in slabs and beams:
      a. Members 8" deep or less: ± 3/8"
      b. Members more than 8" but not over 2' deep: ± 1/2"
      c. Members more than 2': ± 3/4"
   2. Lengthwise of members: ± 2"
   3. Concrete cover to formed surfaces: ± 1/4"
   4. Minimum spacing between bars: ± 1/4"

3.07 CONCRETE PROTECTION

A. Minimum protection for reinforcing steel shall be as follows:
   1. Grade beams and exterior face of walls and columns exposed to the weather or in contact with the ground: 2".
   2. Reinforcing in structural elements deposited against soil: 3".
   3. Beam formed with fiberboard void boxes: 2".
   4. Slabs: 1".

3.08 EMBEDDED METAL ASSEMBLIES

A. Fabricate and assemble structural steel items in the shop. Shearing, flame cutting, and chipping shall be done carefully and accurately. Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Welded construction shall conform to the AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings and AWS D1.1. Welding shall be done by AWS certified welders.

B. Welding of deformed bar anchors and headed stud anchors shall be done by full-fusion process equal to that of Nelson Stud Welding Company.

END OF SECTION 03 20 00

SECTION 03 21 01 - SITE CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This section gives the requirements for the concrete reinforcement to be used in cast-in-place concrete.

1.02 RELATED SECTIONS

A. Section 03 30 54 – Site Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. American Society for Testing and Materials.
      a. ASTM A-615, "Deformed and Plain Billet-Steel Bars for Concrete Reinforcement."
      b. ASTM A-185, "Specification for Welded Steel Wire Fabric for Concrete Reinforcement."
      c. ASTM A-306, "Specification for Carbon Steel Bars Subject to Mechanical Property Requirements."
   2. American Concrete Institute.
      a. ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
      b. ACI 318, "Building Code Requirements for Reinforced Concrete."
   3. Concrete Reinforcing Steel Institute.
      a. CRSI 163, "Recommended Practice for Placing Reinforcing Bars."
      b. CRSI 165, "Recommended Practice for Placing Bar Supports, Specifications and Nomenclature."

1.05 SUBMITTALS

A. When required by the Engineer, submit detailed shop drawings showing the bar locations, splices, sizes, length, type and spacing. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed. Detailing of reinforcement shall be in accordance with the applicable

American Concrete Institute (ACI) reference standard.

1.06 QUALITY ASSURANCE

A. When required by the Engineer, submit the manufacturer's certificates showing the properties of the steel proposed for use. The certificates shall show the manufacturer's test and heat number, chemical analysis, yield point, tensile strength and percent elongation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. All steel reinforcement shall be stored above the ground on platforms, skids or other supports as approved by the Engineer. Reinforcement shall be stored in a location such that it is protected from mechanical injury and rust. When place in the work, steel reinforcement shall be free from dirt, scale, dust, oil, paint and other material. Store steel reinforcement in an orderly fashion so that bars may be easily identified.

1.08 SCHEDULING

A. Schedule the delivery of materials to the site and the installation of the reinforcement such that a minimum time of site storage is maintained for the reinforcement during the entire duration of the project.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Steel Reinforcing Bars. All steel reinforcing bars shall be open hearth new billet steel conforming to ASTM A615. All bars shall be deformed and be Grade 60 with a minimum yield strength of 60,000 psi.

B. Welded Wire Fabric. Wire for fabric reinforcement shall be cold drawn from rods hot rolled from open hearth billets and shall conform to ASTM A82 and be fabricated in accordance with ASTM A185. Wire for fabric reinforcement shall be #4 gauge or have a nominal diameter of 0.2253-inch. Welded wire fabric shall be supplied in flat mats. Rolled fabric will not be accepted.

C. Supports. Supports for reinforcing bars shall be the correct type as intended and represented by the manufacturer. Bar supports shall be uniform high density polyethylene or fiberglass reinforced plastic and conform to CRSI Class 1, Maximum Protection.

D. Spacers. Reinforcing bars shall be spaced the proper distance from the face of the forms by means of approved galvanized metal spacers or approved mortar or concrete blocks. Precast mortar or concrete blocks shall be cast in individual molds, in the form of a frustrum of a cone or pyramid, with suitable tie wire to be used for anchoring the block to the steel. The precast blocks shall be properly cured and aged before use in spacing the steel.

E. Tie Wire. Use 18-gauge annealed steel for tie wire.

F. Bar Splices. Splicing of bars will not be permitted without the knowledge of the Engineer. When splicing of bars is unavoidable, the number of splices shall be kept to a minimum and shall be located at points of minimum stress. When practicable, splices in adjacent bars shall be staggered. Lap splices shall have a minimum splice length of not less than twenty-four (24) bar diameters when being used in 3,000 psi concrete and shall be in accordance with ACI 318. Mechanical splices shall be installed in strict accordance with the manufacturer's instructions and recommendations and shall be as follows:
   1. Mechanical Bar Splices. Use Cadweld splices manufactured by Erico Products, Inc., or preapproved equal. Splices must develop a minimum of 125% of specified yield strength of the spliced bars.
   2. Threaded Bar Splices. Use a metal coupling sleeve with internal threads which receive the threaded ends of the bars to be splice. Splices must develop a minimum of 125% of specified yield strength of the spliced bars.

2.02 FABRICATION

A. Reinforcement shall be bent cold to the shapes indicated on the plan details. Bends shall be true to the shapes indicated and any irregularities shall be cause for rejection. Unless otherwise shown, bends for stirrups or ties shall be made around a pin having a diameter of not less than two (2) times the bar size. Hooks shall be a complete semi-circular turn of a diameter equal to six (6) times the bar diameter, plus an extension of at least four (4) bar diameters at the free end of the bar.

PART 3 - EXECUTION

3.01 PREPARATION

A. Notify the Engineer at least 24-hours before concrete placement so that reinforcement may be observed and errors corrected without delaying the work.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. General. Carefully and accurately place the reinforcement in the positions indicated on the plan details. All reinforcing steel shall be securely wired together at all intersections and be held securely in place during the pouring of concrete.

B. Vertical Stirrups. Vertical stirrups shall always pass around the main tension members and be securely attached thereto.

C. Spacers. No galvanized spacers shall be installed in concrete which will be exposed to the weather.

D. Welded Wire Fabric. Where welded wire fabric is used as reinforcement, the mesh shall be placed in the longest practical lengths and shall be overlapped and securely fastened at the ends to maintain a uniform strength. A minimum of one (1) mesh overlap is required.

E. Construction Joints. Reinforcing shall extend through construction joints.

F. Welding of Reinforcing. No welding of reinforcing steel or splices shall be allowed without the knowledge of the Engineer.

G. Conflicts with the Reinforcement. Where there are conflicts between the location of reinforcing steel and other concrete embedded items, the Contractor shall immediately notify the Engineer so that revisions can be made before placing the concrete. Cutting of any reinforcement is strictly prohibited without the prior knowledge of the Engineer.

3.03 FIELD QUALITY CONTROL

A. Place all reinforcing steel within the specified tolerances as outlined in the referenced standards. Variations from these tolerances will be cause for rejection of the work.

END OF SECTION 03 21 01

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE F

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Concrete for building slab and grade beams.
   2. Concrete for flat work.

B. Related Sections include the following:
   1. Division 03 Section "Concrete Formwork."
   2. Division 03 Section "Concrete Reinforcement."
   3. Division 03 Section “Polished Concrete Floor Finishes”
   4. Division 07 Section "Vapor Barrier Membrane."
   5. Division 09 Section "Painting."
   6. Division 32 Section "Concrete Paving."

1.03 DESCRIPTION

A. Work Included: Furnish all materials, equipment, transportation and facilities, and perform all labor necessary for the following:
   1. Furnish and place cast-in-place concrete.
   2. Grouting structural steel.
   3. Finishing and curing of concrete.
   4. Concrete Mix Designs.
   5. Laboratory testing of concrete.

B. All concrete shall be ready-mixed or transit-mixed, obtained from a plant, the operations of which shall conform to requirements of ASTM C94. Job-mixed concrete shall not be used, except where particularly authorized by the Owner in small quantities such as may be needed to affect patching and repairs.

1.04 REFERENCES

A. The latest adopted edition of all standards referenced in this specification section shall apply, unless noted otherwise.

1.05 SUBMITTALS

A. Submit proposed mix designs prepared in accordance with ACI 301, Chapter 3.9. Each proposed mix design shall be accompanied by a complete standard deviation analysis based on at least 30 consecutive strength tests, or by three laboratory trial mixtures with the confirmation tests.

B. Shop Drawings:

1. Cast-in-place concrete shown on structural drawings, prepared under the supervision of a registered Professional Engineer, including:

   a. Rebar placing drawings (ACI 315-92, Detailing Manual SP-66-80 or CRSI MSP-2-81 "Manual of Standard Practice): Show bar sizes, spacing, locations, and quantities of reinforcing and wire fabric and supporting and spacing accessories. Provide steel order lists including bending and cutting details for all reinforcement shown on the structural design drawings. Provide plans showing beam and pier marks associated with schedules.

   b. Form construction details, including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.

   c. Calculations for any formwork, shoring and/or reshoring.

2. Slab Construction Joint Layout (Training Building Slab(s)): Unless all concrete control and expansion joints in paving are specifically indicated in Drawings, submit complete joint layout indicating proposed construction joint locations to comply with spacing requirements.

   a. Location of joints is subject to approval of Architect and Structural Engineer.

3. Concrete Paving Joint Layout: Unless all concrete control and expansion joints in paving are specifically indicated in Drawings, submit complete joint layout indicating proposed construction joint locations to comply with spacing requirements.

   a. Location of joints is subject to approval of Architect and Civil Engineer.

C. Failure by the contractor to submit the shop drawings, test reports and/or mix designs required above shall release the architect and the engineer from any liabilities due to the negligence on the part of the contractor to comply with the construction documents.

1.06 CONCRETE MIX DESIGNS

A. Selection of proportions: Proportions of ingredients for concrete mixes shall be determined and/or certified by an independent testing laboratory in accordance with the requirements of Chapter 5 of the ACI Standard "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE: (ACI 318-08), to provide characteristics listed on the drawings for each class of concrete.

1. General: Concrete shall be composed of Portland Cement, fine aggregate, coarse aggregate, water, and as specified, an air-entraining admixture. Proportions of ingredients shall produce a mixture which will work readily into corners and angles of forms, bond to reinforcement, without segregation or excessive bleed water forming on the surface. Water-reducing admixture or high range water-reducing admixture (super plasticizer) may be used at contractor's option if properly designed into concrete mix. Use air-entraining admixture in all concrete except piers. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within 2% to 4%. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
   a. Ramps and Sloping Surfaces: Not more than 3".
   b. Reinforced Foundations Systems: 4" plus or minus 1".
   c. Piers: 5" min and 7"max.
   d. Other Concrete: 4" plus or minus 1".

2. Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94, and as herein specified. Addition of water to the batch will not be permitted. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ANSI/ASTM C 94 may be required. When air temperature is between 85° F. (30° C.) and 90° F. (32° C.), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90° F. (32° C.), reduce mixing and delivery time to 60 minutes.
3. Required Average Strength Above Specified Strength: Determinations of required average strength above specified strength shall be based on the standard deviation record of the production facility in accordance with ACI 301. Calculation of standard deviation of compressive strength results shall be in accordance with ACI 214, "Recommended Practice for Evaluation of Comprehensive Test Results of Field Concrete."
4. If a suitable record of past performance is not available, proportions shall be selected on the basis of laboratory trial batches to produce an average strength greater than the specified strength f'c by the amount defined in ACI 301, Table 3.9.2.2.
5. All concrete mix designs shall include the following information:
   a. Proportions of cement, fine and course aggregates and water.
   b. Water-cement ratio, design strength, slump and air content.
   c. Type of cement and aggregates.
   d. Type and dosage of all admixtures.
   e. Special requirements for pumping.
   f. Range of ambient temperature and humidity for which the design is valid.
6. If a testing laboratory provides concrete mix designs, it shall be selected by the Contractor, approved by the Architect and paid for by the Contractor.

1.07 LABORATORY TESTING AND INSPECTION

A. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Architect for final acceptance.

B. Testing agencies shall meet the requirements of "Recommended Practice for Inspection and Testing Agencies for Concrete and Steel in Construction" ASTM E 329.

C. The following testing services shall be performed by the testing laboratory:
   1. Secure concrete samples in accordance with "Method of Sampling Fresh Concrete" ASTM C172-.
   2. Mold and cure four specimens from each sample in accordance with "Method of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31-. The cylinders shall be stored in the field for 24 hours and then transported to the laboratory to be cured.
   3. Test specimens in accordance with "Method for Test for Compressive Strength of Molded Concrete Cylinders" ASTM C39-. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. One specimen shall be held for future testing, if required.
   4. Make one strength test (four cylinders) for each 100 cu. yd. or fraction thereof, of each mix design of concrete placed in any one day.
   5. Determine total air content of air entrained normal weight concrete for each strength test in accordance with ACI 231.
   6. Report test results in writing to the Architect and Structural Engineer on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of contractor, name of concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day test and 28-day tests, and air content.
   7. Determine slump for each strength test and whenever consistency of concrete appears to vary, using "Method of Test for Slump of Portland Cement Concrete" ASTM C143.
   8. Determine temperature of concrete sample for each strength test.

D. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained. Test to determine adequacy of concrete will be by cored cylinders complying with ASTM C42. Contractor shall pay for such test conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

E. Monitor the addition of water at the jobsite and the length of time concrete is allowed to remain in the truck before placement.

F. Testing non-shrink grout: Make one strength test for every 10 baseplates grouted.

G. The Contractor shall provide and pay for the necessary testing services of the following:
   1. Qualification of proposed materials and the establishment of mix designs in accordance with "Building Code Requirements for Structural Concrete" ACI 318.
   2. Other testing services needed or required by the Contractor.

H. To facilitate testing and inspection, the contractor shall:

1. Furnish necessary labor to assist testing agency in obtaining and handling samples at the job site.
2. Advise the testing agency in advance of operations to allow for the assignment of testing personnel and testing.
3. Provide and maintain for the use of the testing agency adequate facilities for proper curing of concrete test specimens on the project site in accordance with "Methods of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31.

I. Evaluation and acceptance:
1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
2. Completed concrete work will be accepted when the requirements of "Specifications for Structural Concrete for Buildings" ACI 301, Chapter 18 have been complied with.
3. In any case, where the average strength of the laboratory control cylinders, as shown by the tests for any portion of the structure, falls below the minimum specified ultimate compressive strength, the Architect shall have the right to require the Contractor to provide improved curing conditions of temperature and moisture to secure the required strength. Also, if the average strength of the laboratory control cylinder should fall so low as to cause the portions of the structure to which the respective unsatisfactory test reports apply to be in question by the Architect, the Contractor shall follow the core procedure set forth in the current edition of ASTM C42. If the results of the core tests indicate, in the opinion of the Architect, that the strength of the structure is inadequate, such replacement, load testing, or strengthening as may be ordered by the Architect shall be provided by the Contractor without cost to the Owner.

J. Reports: The testing laboratory shall make reports to the following:
a. Concrete supplier - 1 copy
b. Contractor - 1 copy
c. Owner - 1 copy
d. Architect - 1 copy
e. Structural Engineer - 1 copy
2. Reports shall be made and distributed immediately after the respective tests or inspections are made.
3. Where reports indicate deviations from the Contract Documents, they shall also include a determination of the probable cause of the deviation and where applicable, a recommendation for corrective action.
4. Wherever the testing laboratory recognizes a trend of decreasing quality in the concrete due to changing reasons, conditions of curing or other cause; this shall be brought to the attention of the Architect, along with a recommendation for corrective action to be taken before the materials fall below the requirements of these Specifications.

K. Authority & Responsibilities of the Testing Laboratory

1. The laboratory representative shall immediately notify the Architect and the Contractor of any deviance from Specifications and approved design mixes observed at the mixing plant or the job site.
2. If, in the opinion of the laboratory representative, the deviance observed will be probable cause for subsequent rejection of the material, he shall so inform the Contractor and Architect so that a timely decision as to whether or not to continue operations can be made.
3. Subsequent to on-the-spot verbal notification, the laboratory shall file a written report of any deficiencies or deviance noted including a summary of conversations and decisions made and action taken at the time in accordance with Paragraph 1.
4. The testing laboratory shall control field adjustments made to concrete mixes to compensate for field conditions and report same in accordance with Paragraph H.

1.08 QUALITY ASSURANCE

A. Materials and work shall conform to the requirements of all standards, code, and recommended practices required in Contract Documents. In conflicts between a standard and the contract Documents, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the local building code, the more stringent requirement shall govern.
   1. Applicable Standards:
      a. "Specifications for Structural Concrete for Buildings" ACI 301-05.
      b. "Building Code Requirement for Structural Concrete" ACI 318-08.
      c. "Standard Specifications for Ready-Mixed Concrete" ASTM C94.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect Products in accordance with Manufacturers' and Division 01 requirements.

B. Deliver materials in unopened containers with labels identifying contents.

C. Store powdered materials in dry area and in manner to prevent damage. Protect liquid materials from freezing.

1.10 PROJECT CONDITIONS

A. Testing: Owner will engage a qualified testing agency to perform pre-construction testing on concrete mixtures. Contractor shall coordinate construction and testing activities with testing agency as required.

B. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

   1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

C. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:

1. Applied Concrete Technology, Incorporated, Grayslake, IL (800) 228-6694.

2. The Euclid Chemical Company, Cleveland, OH (800) 321-7628.

3. Fortifiber Corporation, Reno, NV (800) 773-4777.

4. ChemREX Inc, Shakopee, MN (800) 433-9517.

5. Master Builders Construction Products, Cleveland, OH (800) 227-3350.

6. Sika Corporation, Lyndhurst, NJ (201) 933-8800, (800) 933-7452.

7. WR Meadows, Hampshire, IL (800) 342-5976.

8. Reef Industries, Houston, TX (800) 231-2077.

9. STEGO Industries LLC, San Juan Capistrange, CA (877) 464-7834.

10. L&M Construction Chemicals, Inc., Omaha, NE (402) 453-6600.

11. Curecrete Chemical Company, Inc., Springville, UT (801) 489-5663.

12. Midwest Floor Care Inc., Lincoln, NE (402) 477-2701.

B. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.02 SUSTAINABLE REQUIREMENTS

A. Recycled Content:

1. Concrete: Fly ash shall be used as a substitute for 15 percent of Portland cement where ambient temperatures at the time of pour are expected to be in excess of 70 degrees Fahrenheit, except where limited by other applications, including the following:

    a. Where lower permitted substitution of cement content is otherwise indicated by Civil and Structural Drawings and specifications, and where greater cement to fly ash ratio is required to meet indicated strength requirements.

    b. Where paving standards of authorities having jurisdiction limit substitution for portland cement, comply with requirements of authorities having jurisdiction or as otherwise indicated, whichever requirement is most stringent.

    c. Where chemical stain finish is to be applied.

    d. For densified or densified and polished concrete requiring free lime for chemical reaction, comply with limits for replacement of portland cement in concrete mixes as indicated for specific applications. Refer also to Division 03, Section "Polished Concrete Floor Finishing".

2. Reinforcing Steel: Refer to Division 03, "Concrete Reinforcing".

B. Environmental Impact / Waste Management:

1. Comply with Division 01, Section "Construction Waste Management".

2. Mixing equipment: Return excess concrete to supplier; minimize water used to wash equipment.

2.03 CONCRETE MATERIALS

A. Portland Cement: ASTM C150 - Type I, gray unless otherwise approved.

1. Assume full responsibility for the quality and soundness of cement. Cement is to be of one type and from the same mill; it is to be of uniform color for all concrete with permanently exposed concrete finishes.

B. Requirements for concrete to receive densifier / hardener (but not polished): Comply with the most stringent requirements specified herein, or in structural notes, including:

1. Do not use fly ash and slag as a replacement for portland cement, as indicated for application.

2. Limit use of curing compounds as indicated.

3. Do not use incompatible admixtures.

C. Requirements for concrete to receive polished finish: Refer to Division 03, Section "Polished Concrete Floor Finishing", and notes in Structural Drawings as applicable, for additional information and requirements for concrete to receive polished finish. The most stringent requirements shall apply, including but not limited to the following:

1. Air entrainment is not allowed in concrete to receive polished finish.

2. Chemical admixtures, curing compounds, and other topical applications shall be used with concrete to receive polished ONLY IF they are chemically compatible with the polishing products and process and are specifically approved by the Architect and by the polishing system Manufacturer.

    a. Concrete to be polished shall be only wet cured with potable water, unless otherwise approved by Architect.

D. Admixtures: The following admixtures are permitted when approved in writing prior to use or are required as specified herein and shall be used in strict accordance with the manufacturer's specifications or recommendations:

E. Calcium chloride: Conform to ACI 301. The chloride ion level shall not exceed 0.3 percent.

F. Air-entraining admixtures: ASTM C260 shall be used to achieve the specified air content in all permanently exposed exterior concrete. For steel trowel interior slab finish, do not use air entrainment admixtures and total air entrainment must not exceed 3%. For steel trowel exterior slab finish, comply with ACI 318 and ACI 302.

    1. Euclid: AEA-92 or Air Mix 200.

G. Water-reducing admixtures: Conform to ASTM C494, Type A, containing not more chloride ions than allowed in paragraph C., above.

    1. Euclid: Eucon WR series or Eucon MR.

H. Water-reducing/accelerating admixtures: Conform to ASTM C494, Type C or E having long-term test results showing non-rusting on metal deck and reinforcing steel.

    1. Euclid: Accelguard series.

I. Water-reducing/retarding admixtures: Conform to ASTM C494, Type D containing not more than 1 percent chloride ions.

    1. Euclid: Eucon Retarder series.

J. High-range/water-reducing (HRWR) admixtures: Conform to ASTM C494, Type F or G super plasticizers containing 1 percent maximum chloride ions may be used with low slump (3 inches maximum) concrete to produce flowable concrete (up to 8 inches slump) with early strength gain and 28-day strengths equal to reference concrete. HRWR admixture may be used providing not more than 60 minutes is allowed from addition of admixture to final placement of concrete. HRWR admixture shall be used in concrete with a maximum water/ cement ratio of 0.50 or less and is suggested in the following:

    1. In pumped concrete.

    2. In concrete topping slabs

3. In lieu of the specified water-reducing admixture (Type A) where confinement of placing due to heavy reinforcement or narrow space requires flowable concrete.

4. Where more than 30 minutes is required between the addition of admixtures to final placement of the concrete, a combination of water-reducing, set controlling admixtures (ASTM C494, Types A, D, & E) as in Master Builders Company "Synergized Performance System" may be used.

   a. Euclid: Eucon 37 or Eucon 537.

K. Certification: Certification of the above requirements is required from the admixture manufacturer prior to mix design review and approval by the Architect. Upon request by the Architect, a qualified representative is to be provided to assure proper use of admixtures. Use of admixtures, other than listed above will be permitted only when approved.

L. Aggregates:

1. Normal-weight concrete - ASTM C33. For slabs, also conform to combined aggregate grading recommendations of ACI 302 and ACI 302.1R, unless otherwise permitted.

2. All concrete exposed to the weather shall conform to the limits of deleterious substances and physical properties of Table 3, ASTM C 33.

3. Local aggregates: Local aggregates not complying with ASTM C33 but which have been shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Architect.

4. Maximum size of coarse aggregates: ACI 301.

5. Abrasive aggregates non-slip finishes: Fused aluminum oxide grits, or crushed emery, as abrasive for non-slip finish with emery aggregate containing not less that 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, non- glazing, and unaffected by freezing, moisture, and cleaning materials.

M. Water: Clean and not detrimental to concrete; drinkable.

N. Fibrous Reinforcement: Not used

2.04 FINISHING MATERIALS

A. Cement Floor Leveling Compound: Camp's "Latex Mix" (Liquid Felt up to 1/8" over 1/8" mix with Portland Cement and Sand), as distributed by the Tichenor Company, Dallas, Texas or approved equal. Floor leveling compound may only be used where floor will not be exposed.

B. Abrasive Aggregate for Non-slip Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40% aluminum oxide and not less than 25% ferric oxide. Use material that is factory

graded, packaged, rust-proof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

C. Refer to Division 09, Section "Painting", for application of hardener/densifier at unpolished sealed concrete floors in mechanical and similar spaces.

D. Evaporation retarder: “Confilm” by Master Builders; spray applied liquid film for hot weather finishing.

2.05 GROUT / MORTARS

A. Cement grout: Conform to ASTM C387 "Dry packaged mixtures" or:

1. Mix at the site, in composition of one volume of Portland cement to 2-1/2 volumes of fine aggregate.

2. Mix the materials dry; then add sufficient water to make the mixture flow under its own weight.

3. Submittals: The following laboratory test results shall be submitted to show compliance with the requirements of this specification:

   a. Initial setting time: 8 hours maximum

   b. Vertical shrinkage: 0

   c. Compressive strength: 4500 psi 1 day

   d. Compressive strength: 8500 psi 7 days

   e. Compressive strength: 10,000 psi 28 days

4. Field service: When required by the Architect, provide a qualified concrete technician employed by the Grout Manufacturer to assist in the initial grouting operations.

   a. Euclid: NS Grout or Hi Flow Grout or E3 Grout series.

   b. Sika: Sika Grout #212.

2.06 CURING MATERIALS

A. Method of curing shall be approved by the finish flooring applicator where finishes are indicated.

B. Wet Cure Blanket: Waterproof covering, for curing exposed finish concrete floors, shall be non-staining, reinforced with fibers, and conforming to the requirements of the current edition of ASTM C171-03, ASTM C171-97a, and AASHTO M171-00, standard specifications for sheet material for curing concrete slabs. McTech Group, Inc.; "UltraCure NCF", Loganville, GA (866) 913-8363, or comparable product by another Manufacturer.

C. Curing Compounds:

1. For Slabs not scheduled for Chemical Hardener: Clear Bond as made by Guardian Chemical Co., Acri-Seal as made by Toch Bros., Dress and Seal as made by L & M Construction Chemicals, MasterKure as made by Sonneborn, or Res-X Cure by Burke Concrete Accessories.

2. For Slabs to be Chemically Hardened: Do not use film-forming curing compounds. Where curing compound is required, a non-film-forming curing compound chemically compatible with the hardener may be used, if first approved by the chemical hardener Manufacturer Dissipating liquid membrane-forming compounds for curing concrete; Conform to ASTM C309, Type 1. Curing compound shall be compatible with floor sealer or finish used. Low VOC. At polished concrete finishes, use of curing compounds is not allowed unless specifically approved by the Architect and polishing system Manufacturer.

    a. Euclid: VOX Kurex DR series; waterborne products.

    b. W.R. Meadows: 1100 series.

    c. L&M Construction Chemicals: Cure R.

    d. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Permitted.

D. Evaporation retarder: "MasterKure ER 50" by BASF or equal; spray applied liquid film for hot weather finishing.

1. Do not use evaporation retarder at slabs to be densified, unless specifically approved for compatibility by the densifier manufacturer.

E. Water: Potable.

2.07 SEALERS AND DENSIFIER / HARDENERS

A. Exterior Sealers: applied to horizontal concrete surfaces permanently exposed to salts, deicer chemicals and moisture, including parking decks. The manufacturer shall provide a 5-year labor and materials Warranty on performance of the sealer. Sealer shall be compatible with the curing compound used.

1. Euclid: Eucoguard or Diamond Clear or Super Diamond Clear.

2. ChemREX: Hydrozo Clear 40.

3. Substitutions: Permitted.

B. Floor Sealing Compound: "Master Seal 330" by Master Builders, Cleveland, Ohio or approved equal.

C. Concrete Densifier / Sealer for Interior Concrete: Coordinate requirements of hardener/densifier products with concrete mix designs and chemical admixtures and curing methods. These products are chemically reactive with the free lime in concrete and performance and appearance will be adversely affected by chemicals that react with lime or

that impede the ability of the hardener/densifier to react. Do not use chemical admixtures or curing compounds unless specifically approved in writing. Limit fly ash replacement of portland cement to 20% in concrete mix designs for slabs to receive these finishes unless specifically approved in writing by Architect and Structural Engineer:

1. Exposed concrete floor slabs not indicated for polished finish**,** in Apparatus Bay support areas, Ground floor Mechanical Rooms, Electrical Rooms, Storage Rooms, and similar spaces as indicated on Finish Plans: Two- or Multiple-Coat, spray-applied, hardener/densifier. Chemical reactive magnesium fluorosilicate formulation with chemical resistant properties to alkali, acids, oils and salts, and does not substantially change appearance of concrete surfaces. Provide one of the following or approved equal product by another Manufacturer:
   a. BASF; "MasterKure HD 300 WB".
   b. Euclid Chemical Co; "Surf-Hard".
2. Exposed concrete floor slabs with smooth troweled finish: One coat flood-applied, hardener/densifier. Chemical reactive silicate / siliconate formulation that enhances sheen level of troweled concrete and is designed to mainatin or increase sheen level over time with normal wear. Provide one of the following or approved equal product by another Manufacturer:
   a. CureCrete Chemical Company; "Ashford Formula", www.ashfordformula.com.
   b. Dayton Superior; "Sure-Hard Densifier J17", www.daytonchemical.com.
   c. Euclid Chemical Company; "Euco Diamond Hard", www.euclidchemical.com.
   d. L&M Construction Chemicals: "Seal Hard", www.lmmc.com.
3. Refer to Division 03 "Special Concrete Floor Finishes" for floor polishing system.

Commented [SH1]: <--"Lapidolith" product name is discontinued, the "Sonneborn" product names have mostly been phased out by BASF. The BASF product name is now this...

Commented [SH2]: <-- Super Rez Seal is an applied acrylic product and not same product class as MasterKure HD 300 WB. We want the chemical resistance of the magnesium fluorosilicate, so I replaced Super Rez Seal with Euclid's simliar product.

2.08 JOINTS AND EMBEDDED ITEMS:

A. Construction and Contraction Joints: Comply with ACI 301 and recommendations of ACI 302.1R. Sealant shall be two-part semi- rigid epoxy, and shall have minimum Shore A Hardness of 80 when measured with ASTM D2240. A product that complies with these requirements is "Euco 700", as manufactured by The Euclid Company, Cleveland, OH (800) 321-7628.

B. Isolation Joints: Fillers shall consist of 1/8 inch width strips of neoprene, synthetic rubber, or approved substitute, extending the full depth of the slab. Sealant shall be two-part elastomeric type, polyurethane base.

2.09 MISCELLANEOUS MATERIALS

A. Expansion Joint Material: Preformed expansion joint material conforming to ASTM D-1751.

B. Drilled Anchor Bolts: Shall be "Wej-It" bolts as manufactured by the WEJ-IT Corp., Broomfield, Colorado; "Kwik Bolt II", by Hilti Fastening Systems; "Trubolt" as manufactured by Ramset Fastening Systems; or approved equal.

C. Rust Inhibitor: For field application to metal accessories shall be Hi-Build Epoxoline manufactured by the Tnemec Co., Inc., Kansas City, Missouri or approved equal.

D. Epoxy for Patching: Shall be a two-component polymer modified cementitious system equal to Sikatop series as manufactured by Sika Chemical Corp., Lyndhurst, New Jersey or approved equal. Sikatop product selected shall be appropriate for intended repair and shall be approved by Architect.

E. Accessories: AC315 Galvanized chairs, stools, spacers, etc. shall be by Superior Manufacturing Co., or equal.

F. Waterstop: Preformed flexible PVC CE VRD-C572 waterstop for embedding in concrete to prevent passage of fluids through joints. Factory-fabricate corners, intersections and directional changes. Acceptable manufacturers include:

1. W. R. Meadows
2. Greenstreak
3. Tamms Industries

2.10 VAPOR BARRIER

A. Provide cover over prepared soil, below aggregate base material at slabs-on- ground unless otherwise noted on the plans. Use only materials which are resistant to decay when coated in accordance with ASTM E154.

1. Vapor Barrier:
    a. STEGO: STEGO WRAP VAPOR BARRIER
    b. Fortifiber: Moistop 1 or 2 Premium.
    c. RAVEN: RUFCO VAPOR BLOCK
    d. Or approved equal.

2.11 PROPORTIONING

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If laboratory trial batch method is used, use an independent testing facility acceptable to Architect for preparing and reporting

proposed mix designs. The testing facility shall not be the same as used for field quality control testing and inspection unless otherwise acceptable to Architect.

B. Submit written reports to the testing laboratory of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed and approved. Include the following information for each concrete mix design:

1. Method used to determine the proposed mix design.
2. Gradation of fine and coarse aggregates, plus combined aggregate gradation for slabs, ACI 302.
3. Proportions of all ingredients including all admixtures added either at the time of batching or at the job site.
4. Water-cement ratio.
5. Slump, ASTM C143.
6. Certification of the chloride content of individual admixtures and of the mixes as proposed.
7. Air Content: ASTM C173 (Volumetric Method).
8. Unit weight of concrete, ASTM C138.
9. Strength at 4, 7, and 28 days, ASTM C39.
10. Method of recording batch proportions.
11. Substantiating test reports.

C. Concrete types and strengths: Minimum 28 Day Compressive Strength shall be per design requirements but not less than:

1. Slabs on ground, paving base, columns, beams, walls, foundations, and footings: 3,000 psi.
2. Normal or Lightweight concrete on metal deck: 3,000 psi.
3. Tilt-up: 4,000 psi.
4. All concrete exposed to weather shall be air entrained (ASTM C260).
5. All concrete shall be normal weight except as noted above.
   Also, see general and specific notes on structural drawings.

D. Weights: All concrete shall be normal-weight concrete unless otherwise designated on the structural drawings.

E. Durability: Conform to ACI 301.

1. All concrete exposed to potentially destructive weathering, such as freezing and thawing, or to de-icer chemicals is to be air-entrained, 6 percent ±1percent, six sacks cement/cu. yd. min., 4" max. slump.

2. Water-cement ratio: For concrete subject to freezing and thawing or deicer chemicals, the water-cement ratio shall not exceed 0.53 by weight including any water added to meet specified slump in accordance with the requirements of ASTM C94 unless otherwise noted.

F. Slump: Conform to ACI 301.

1. 4 ½ inch maximum for consolidation by vibration

2. 5 inch maximum for consolidation by other methods

3. 8 inch maximum for flowable concrete. Concrete containing HRWR admixture (super plasticizer): 3 inch maximum before addition of HRWR

4. Where field conditions require slump to exceed that specified above, the increased slump shall be obtained by the use of a superplasticizer only, and the Contractor shall obtain written approval from the Architect who may require an adjustment to the mix.

G. Production of concrete: Conform to ACI 301:

1. Ready-mixed concrete:

a. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C94.

b. All concrete shall be proportioned conforming to the approved mix designs and of the materials contained in those approved mixes. A certified copy of the design weights for each mix shall be kept at the producing plant for each class of concrete used on the project.

c. Plant equipment and facilities are to conform to the "Check List for Certification of Ready -Mixed Concrete Production Facilities" of the National Ready-Mixed Concrete Association and have NRMCA or approved certification within the past year.

2. All other concrete: Conform to ACI 301

3. Concrete produced by on-site volumetric batching and continuous mixing if approved shall conform to ASTM C685.

4. Use of accelerating admixtures in cold weather and retarding admixtures in hot weather shall not relax placement requirements specified herein.

5. Admixtures: ACI 301. All concrete placed at ambient temperatures below 50 degrees F is to contain an approved accelerator. All concrete placed at ambient temperatures above 80 degrees F is to contain an approved retarder. All concrete required to be air-entrained is to contain an approved air-entraining admixture. When improved workability,

pumpability, lower water-cement ratio, or high ultimate and/or early strength is required, the HRWR admixture (super plasticizer) may be used.

6. Ensure air content for slabs with steel trowel finish is less than 3.0 percent. The concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around reinforcement without permitting materials to segregate or free water to collect on the surfaces. Within the limiting requirements, adjust the consistency of the concrete as may be necessary to produce mixtures which will be placeable with reasonable methods of placing and compacting. Maintain on the job at all times adequate extra cement to be used at rate of 1/2 sack cement per cubic yard concrete for each 2" slump increase for corrections due to wetness desired or obtained. No water shall be added to concrete except under the direct awareness of the project inspector.

7. Adjustments to concrete mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant at no additional cost to Architect. Laboratory test data for revised mix design and strength results must be submitted and accepted before using in work.

2.12 FORMWORK

A. Division 03 Section - Concrete Forms and Accessories

2.13 REINFORCING MATERIALS

A. Division 03 Section - Concrete Reinforcement

PART 3 - EXECUTION

3.01 EXAMINATION

A. Division 01 Section - Execution Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

C. Report in writing to Architect prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 INSTALLATION - GENERAL

A. Install all cast-in-place concrete work in accordance with ACI 301 except as herein specified.

3.03 INSTALLATION - FORMWORK

A. Division 03 Section - Concrete Forms and Accessories

B. Construction and Contraction Joints: Conform to ACI 301 and recommendations of ACI 302.1R.

3.04 REINFORCEMENT

A. Placement: Division 03 Section - Concrete Reinforcement

3.05 CONCRETE (CONVEYING AND DEPOSITING)

A. Placement: Conform to ACI 301:

1. Maintain concrete cover around reinforcing as specified herein and ACI 301.

2. Pumping concrete: ACI 304.2-R.

3. Cold-Weather Placement: Comply with provisions of ACI 306.1 "Standard Specifications for Cold-Weather Concreting" and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

4. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

   a. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

   b. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

5. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305R "Standard Specification for Hot-Weather Concreting" and as specified.

   a. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

   b. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.

   c. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.

d. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

B. Protection of cast concrete: Conform to ACI 301.

C. Where the use of synthetic fibers is specified, fibers shall be added at a rate of 5.0 million fibers per cubic yard.

D. Repair of surface defects: ACI 301.

1. Inspect concrete surfaces immediately upon removal of forms. Patch imperfections as needed or as directed by the Architect.

2. Modify or replace concrete not conforming to required thickness, lines, details, and elevations.

3. Repair or replace concrete with excessive honeycombing and other defects due to improper placement. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

4. Tie holes shall be filled solid with patching mortar.

3.06 FINISHING

A. Finishing of formed surfaces: ACI 301:

1. Tops of forms:

a. Strike concrete smooth at tops of forms.

b. Float to texture comparable to formed surfaces.

2. Formed surfaces:

a. Permanently exposed surfaces and surfaces to be painted: ACI 301 - "Smooth Form Finish" with the fins ground smooth and air holes or honeycomb filled with mortar.

b. Surfaces in unfinished areas unexposed to public view: ACI 301- "Rough Form Finish".

B. Slabs: Minimum slab surface tolerance must satisfy ACI 301 and ACI 302.1R as measured in accordance with ASTM E1155.

1. Slabs-on- ground:

a. Preparation of sub-grade: Compact stone base aggregate to thickness indicated on drawings. Roll poof stone screenings topping to provide smooth hard surface on which to place slab. Surface should not show footprints or truck tracks when driven over.

b. Place floor slabs-on- ground by "strip cast" method. Contraction joints where shown on drawings shall be saw-cut (as soon as slab has set enough to allow working on but

not before it has set enough to prevent raveling) 1/4 of the depth of slab thickness. It is recommended to use a SOFF-CUT saw and blades (between 1 to 4 hours after finish typically with 1 inch minimum depth) for all contraction joints as per manufacturer recommendations.

c. For exposed slabs, install semi-rigid epoxy sealant in construction and contraction joints after slab has fully dried.

d. Separate slabs-on- ground from vertical surfaces with 1/2 inch-thick joint filler. Extend joint filler from bottom of slab to within 1/8 inch of finished slab surface.

e. Allowable tolerance for slab on grade surfaces, measured in accordance with ACI 117 and ASTM E1155, shall meet or exceed an overall value of FF35/Fl25, with minimum local value of FF24/FL17.

2. Suspended Floor Slab:

a. Minimum surface tolerances: FF25 & FL20 overall FF20 & FL15 local.

C. Float Finish:

1. Locations: All concrete surfaces under mud-set tile or pavers.

2. Finishing: After concrete has stiffened sufficiently and bleed water has evaporated, the surface shall be wood floated to produce a uniform texture with no coarse aggregate visible. Apply sufficient pressure to bring the moisture to the surface.

D. Trowel Finish:

1. Locations: All concrete surfaces under:

a. Thin set tile

b. Carpets

c. Vinyl floor tile

d. Exposed concrete

e. Typical unless noted otherwise

2. Troweling: Steel trowel not less than two passes. Begin troweling with power trowel as soon as little or no cement sticks to the blades. Dusting with dry cement or aggregate to stiffen mix or absorb moisture is not allowed. The concrete shall then be hand troweled or machine troweled to produce a smooth impervious surface for the purpose of burnishing.

E. Broom Finish:

1. Locations: Exterior stairs, ramps, walks and other locations where noted on the drawings.

2. Finishing: Same method as specified for trowel finish, except after initial troweling brush concrete surfaces with a soft brush or broom to texture as specified by the architect.

F. Power Machine Finishing: In place of hand finishing, the Contractor may use a power machine approved by the Architect for finishing the concrete surfaces for finishing the concrete surfaces. However, the preparation of concrete surfaces for finishing by machine shall be, in general, as hereinbefore required for hand finishing.

G. Non-slip Finish: Apply abrasive aggregate at the rate of 25 lbs. per 100 SF per manufacturer's instructions in areas specified.

3.07 CURING AND PROTECTION

A. Protect all freshly placed concrete from washing by rain, flowing water, etc. Do not allow concrete to dry out from the time it is deposited in the forms until the expiration of the curing period hereinafter specified. The methods of curing shall be as specified in the following paragraphs, unless otherwise authorized by the Architects.

B. Concrete surfaces, not otherwise specified, shall be cured by being kept wet with clean water for a period of not less than seven (7) days after placing. Each day the forms are left in place, and kept wet enough to prevent the opening of joints in the forms and the drying out of the concrete, will be counted as one (1) day of curing.

C. In lieu of the wetting specified above, the Contractor may, , use a non-bituminous liquid sealing and curing compound to seal the moisture in the concrete. Such material shall not, however, be applied to surfaces which are to receive further concrete, mortar, resilient tile or liquid vinyl coating. Curing liquid, if used, shall be applied in conformity with the recommendations of the manufacturer of the material approved for use, and to sufficient extent to effectively hold the moisture in the concrete. The use of such material shall not relieve the Contractor of the responsibility of protecting all floor slabs, platforms, and steps whenever any scaffolding, shoring, form work, masonry, concrete or other work is being done over or above finished concrete slabs.

D. Permanently exposed concrete floors shall be cured by covering the entire surface, as soon as practical after finishing, with waterproof paper, laid with four-inch (4") lapped joints. The joints shall be covered with gummed tape or be glued with waterproof glue. Such covering shall remain in place until completion of the building, except on surfaces where ceramic tile is to be applied, in which cases the covering shall be removed after a period of seven (7) days has elapsed after the placing and finishing of the concrete. Tears in paper shall be repaired.

E. Imperfect or damaged work, or any material damaged or determined to be defective before final completion and acceptance of the entire job, shall be satisfactorily replaced at the Contractor's expense, and in conformity with all of the requirements of the Drawings and Specifications. Removal and replacement of concrete work shall be done in such manner as not to impair the appearance or strength of the structure in any way.

F. Cleaning: Upon completion of the work, all forms, equipment, protective coverings and any rubbish resulting therefrom shall be removed from the premises. Finished concrete surfaces

shall be left in a clean condition, satisfactory to the Owner. After sweeping with an ordinary broom and removing all mortar, concrete droppings, loose dirt, mud, etc., wash all concrete floors and platforms with soapsuds and scrub with a stiff fiber brush. Mop up the suds and flush the surfaces with clean water. Provide adequate measures during scrubbing, mopping, and flushing operations to keep excessive or injurious amounts of water off resilient tile floors. Any damage to such floors shall be promptly, effectively and satisfactorily repaired.

3.08 PATCHING AND REPAIR

A. Comply with ACI 301 and ACI 503.2 for standard specifications for bonding plastic concrete to hardened concrete with a multiple component epoxy adhesive.

B. Remove honeycomb voids, cracks, and irregularities. Where repair is required, cut back defects not less than 1/2" with square edges, brush out, drench with water and fill with concrete of same mix from which coarse aggregate is removed. When cut-outs have been filled, trowel surface smooth, remove excess grout and after set, grind slightly to uniform color and appearance using neat Portland Cement applied with a power grinder wheel.

3.09 GROUTING

A. After steel columns have been installed and leveled, grout the space between the bottom of the plate and concrete, using cement grout completely filling the space and forming solid bearing for the column base plate.

3.10 EVALUATION AND ACCEPTANCE OF CONCRETE

A. Comply with ACI 301.

3.11 ACCEPTANCE OF STRUCTURE

A. Comply with ACI 301.

3.12 MISCELLANEOUS CONCRETE

A. Curbs: Provide monolithic finish to interior surface of curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

B. Equipment bases and foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment with template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

3.13 FIELD QUALITY CONTROL

A. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Architect for final acceptance.

B. Testing agencies shall meet the requirements of "Recommended Practice for Inspection and Testing Agencies for Concrete and Steel in Construction" ASTM E 329.

C. The following testing services shall be performed by the testing laboratory:

1. Secure concrete samples in accordance with "Method of Sampling Fresh Concrete" ASTM C172-.

2. Mold and cure four specimens from each sample in accordance with "Method of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31-. The cylinders shall be stored in the field for 24 hours and then transported to the laboratory to be cured.

3. Test specimens in accordance with "Method for Test for Compressive Strength of Molded Concrete Cylinders" ASTM C39-. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. One specimen shall be held for future testing, if required.

4. Make one strength test (four cylinders) for each 100 cu. yd. or fraction thereof, of each mix design of concrete placed in any one day.

5. Determine total air content of air entrained normal weight concrete for each strength test in accordance with ACI 231.

6. Report test results in writing to the Architect and Structural Engineer on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of contractor, name of concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day test and 28-day tests, air content.

7. Determine slump for each strength test and whenever consistency of concrete appears to vary, using "Method of Test for Slump of Portland Cement Concrete" ASTM C143.

8. Determine temperature of concrete sample for each strength test.

D. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained. Test to determine adequacy of concrete will be by cored cylinders complying with ASTM C42. Contractor shall pay for such test conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

E. Monitor the addition of water at the jobsite and the length of time concrete is allowed to remain in the truck before placement.

F. Testing non-shrink grout: Make one strength test for every 10 baseplates grouted.

G. The Contractor shall provide and pay for the necessary testing services of the following:

1. Qualification of proposed materials and the establishment of mix designs in accordance with "Building Code Requirements for Structural Concrete" ACI 318.

2. Other testing services needed or required by the Contractor.

H. To facilitate testing and inspection, the contractor shall:

1. Furnish necessary labor to assist testing agency in obtaining and handling samples at the job site.

2. Advise the testing agency in advance of operations to allow for the assignment of testing personnel and testing.

3. Provide and maintain for the use of the testing agency adequate facilities for proper curing of concrete test specimens on the project site in accordance with "Methods of Making and Curing Concrete Compression and Flexural Specimens in the Field" ASTM C31.

I. Evaluation and acceptance:

1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.

2. Completed concrete work will be accepted when the requirements of "Specifications for Structural Concrete for Buildings" ACI 301, Chapter 18 have been complied with.

3. In any case, where the average strength of the laboratory control cylinders, as shown by the tests for any portion of the structure, falls below the minimum specified ultimate compressive strength, the Architect shall have the right to require the Contractor to provide improved curing conditions of temperature and moisture to secure the required strength. Also, if the average strength of the laboratory control cylinder should fall so low as to cause the portions of the structure to which the respective unsatisfactory test reports apply to be in question by the Architect, the Contractor shall follow the core procedure set forth in the current edition of ASTM C42. If the results of the core tests indicate, in the opinion of the Architects, that the strength of the structure is inadequate, such replacement, load testing, or strengthening as may be ordered by the Architects shall be provided by the Contractor without cost to the Owner.

J. Reports: The testing laboratory shall make reports to the following:
Concrete supplier - 1 copy
Contractor - 1 copy
Owner - 1 copy
Architect - 1 copy
Structural Engineer - 1 copy

1. Reports shall be made and distributed immediately after the respective tests or inspections are made.

2. Where reports indicate deviations from the Contract Documents, they shall also include a determination of the probable cause of the deviation and where applicable, a recommendation for corrective action.

3. Wherever the testing laboratory recognizes a trend of decreasing quality in the concrete due to changing reasons, conditions of curing or other cause; this shall be brought to the attention of the Architect, along with a recommendation for corrective action to be taken before the materials fall below the requirements of these Specifications.

K. Authority & Responsibilities of the Testing Laboratory

1. The laboratory representative shall immediately notify the Architect and the Contractor of any deviance from Specifications and approved design mixes observed at the mixing plant or the job site.

2. If, in the opinion of the laboratory representative, the deviance observed will be probable cause for subsequent rejection of the material, he shall so inform the Contractor and Architect so that a timely decision as to whether or not to continue operations can be made.

3. Subsequent to on-the-spot verbal notification, the laboratory shall file a written report of any deficiencies or deviance noted including a summary of conversations and decisions made and action taken at the time in accordance with Paragraph 1.

4. The testing laboratory shall control field adjustments made to concrete mixes to compensate for field conditions and report same in accordance with Paragraph H.

END OF SECTION 03 30 00

SECTION 03 30 54 - SITE WORK CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

A. This section gives requirements for normal weight structural concrete, concrete riprap, and pneumatically placed concrete.

1.02 RELATED SECTIONS

A. Section 03 11 14 – Site Concrete Formwork

B. Section 03 15 17 – Site Concrete Reinforcement

C. Section 03 21 01 – Site Concrete Joints and Embedded Items

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ACI - American Concrete Institute
   2. ASTM - American Society for Testing and Materials

1.05 SYSTEM DESCRIPTION

A. Four (4) classes of concrete designated by the minimum seven (7) day and twenty-eight (28) day compressive strength in pounds per square inch (psi) are covered by this specification and are as follows:

	Compressive Strength (psi)	
Class	7 days	28 days
A	1,350	2,000
B	1,700	2,500
C	2,000	3,000
D	2,350	3,500

B. Unless shown otherwise on the Drawings, concrete shall be Class “D”.

1.06 SUBMITTALS

A. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed.

B. Submit the following information for the review and approval of the Engineer:
   1. Cement. Submit certified test reports for the cement to be used on the project.
   2. Aggregate. Submit certified test reports for the aggregate to be used on the project. Testing of aggregate shall be conformance with ASTM C33.
   3. Admixtures. Submit brochures, manufacturers instructions for use, and performance data on all proposed admixtures.
   4. Design Mix. Submit test data on proposed design mixes for each class of concrete to be used on the project. Test data shall include both the 7-day and 28-day compressive strength tests results to establish a quality control standard for use during the construction period. No concrete shall be placed before the design mix is submitted and approved. An analysis showing the relationship between the water-cement ratio and the compressive strength of the concrete mix shall be submitted with the design mix.

1.07 QUALITY ASSURANCE

A. It shall be the responsibility of the Contractor to produce concrete of the strength, durability, workability and specified finish; furnish representative materials for specimens in quantities required by the testing laboratory; take samples of materials for testing; check proportions of mix and immediately notify the Engineer if proportions appear improper in any respect. The Contractor shall comply with all testing laboratory findings and the Engineer's decisions in reference to these findings. The Contractor shall pay for the redesign of the concrete mix due to a change in the source of materials.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Cement. Store cement in weathertight buildings, bins or silos to provide protection from dampness and contamination and to minimize warehouse set.

B. Aggregate. Arrange and use aggregate stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Do not use frozen or partially frozen aggregates.

C. Sand. Sand shall be stored such that it maintains a uniform moisture content.

D. Admixtures. Store and handle admixtures in accordance with manufacturer's instructions.

E. Batch Tickets. Batch tickets shall be delivered with each load of concrete and shall include the weights of each ingredient for the batched load of concrete and the date and time the load was batched. The testing agency representative shall keep at least one (1) copy of the batch ticket.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Portland Cement. Portland cement shall be Type I or Type III and be in accordance with the current specifications for Portland cement in ASTM C150. Type IA or Type IIIA Portland cement shall be used when air entrainment is specified and shall conform to the current specifications for Portland cement in ASTM C175.

B. Fly Ash. When fly ash is used, "cement" shall be defined as "cement plus fly ash". Fly ash shall be Type C from a source approved by the Texas Department of Transportation and shall not exceed 25% of the absolute volume of the "cement plus fly ash". Fly ash is not permitted when white Portland cement is required.

C. Water. Water used for mixing in concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement. Water which is suitable for drinking or ordinary household uses is acceptable. Nonpotable water shall not be used for mixing in concrete. The maximum water/cement ratio shall be 0.50.

D. Admixtures. Calcium chloride or admixtures containing chloride are strictly prohibited. Provide admixtures in accordance with the following:
   1. Air-entraining Admixtures. Use admixture which conforms to the requirements of ASTM C260.
   2. Chemical Admixtures. Chemical admixtures used as retarders, accelerators, water-reducing agents, or a combination of these, shall conform to the applicable provisions of ASTM C494 and/or ASTM C1017.
   3. Admixtures shall be charged into the mixer as solutions and shall be measured accurately. The liquid shall be considered a part of the mixing water.

E. Aggregates. Use coarse aggregate from only one (1) source and fine aggregate from only one (1) source for all exposed concrete in a single structure. Use of pit run gravel as an aggregate will not be permitted. Both fine and course aggregates in normal weight concrete shall conform to the requirements of ASTM C33 and shall be as follows:
   1. Coarse Aggregate. Course aggregates shall consist of crushed stone,

gravel, crushed gravel or a combination of these. Gravel and crushed gravel shall consist of clean, hard, durable particles, free from adherent coating, thin or elongated pieces, soft or disintegrated particles, dirt, organic or injurious matter. Crushed stone shall consist of the clean, dustless product resulting from crushing stone. There shall be no adherent coatings, clay, loam, organic or injurious matter.

2. Fine Aggregate. Fine aggregate shall consist of a sand or mixture of sand with or without a mineral filler. The sand or mixture of sand in fine aggregate shall be clean, hard, durable, uncoated grains which are free from lumps.

F. Curing Compound. When required, provide commercial curing compound which will not permanently discolor the concrete and is in accordance with the provisions set forth in ASTM C309.

G. Sheet Material for Curing Concrete. When required, provide waterproof paper, polyethylene film or white burlap-polyethylene sheeting in accordance with provisions set forth in ASTM C171.

H. Patching Grout. Provide a non-shrink, non-slump, quick-setting patching mortar to repair small defects in concrete work. Master Builders' "Embeco 153," or preapproved equal, is acceptable for use as a patching grout. Sand used in patching grout shall be in accordance with the provisions set forth in ASTM C144.

I. Proportioning and Mixing of Concrete. Proportion and mix ingredients in a manner that will produce a concrete having the proper placability, durability, strength, appearance, and other specified properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement when placed and consolidated and will not segregate or have excessive water collect on the surface. Proportion materials in accordance with the procedures outlined in ACI 613, "Recommended Practice for Selecting Proportions for Concrete." All materials will be proportioned and mixed with the intention of producing a concrete with the minimum specified twenty-eight (28) day compressive strength, or greater.

1. Normal Weight Structural Concrete. In addition to the above requirements for proportioning and mixing concrete, normal weight structural concrete shall be mixed in accordance with the provisions of ASTM C94, "Standard Specification for Ready-Mixed Concrete." The use of an on site batch plant is strictly prohibited without the prior approval of the Engineer. Any specified or approved admixtures shall be mixed and proportioned in the concrete in accordance with the manufacturer's instructions and the applicable reference standards.
2. Concrete Riprap. Concrete riprap shall be proportioned and mixed in accordance with the provisions for normal weight concrete.
3. Pneumatically Placed Concrete. In addition to any of the following

requirements, the cement, sand, admixtures, and water to be used for pneumatically place concrete shall conform to the requirements previously outlined in this specification. Pneumatically placed concrete shall be proportioned as follows:

a. Type I. One (1) part cement (minimum) to four (4) parts sand (by volume).

b. Type II. One (1) part cement (minimum) to five (5) parts sand (by volume).

4. The type to be used shall be designated on the Drawings. At the time of mixing, the sand shall contain from three (3) to six (6) percent moisture. When visual inspection indicates that lumps or oversized particles are going into the machine, all materials shall be thoroughly mixed and passed through a 1/4-inch sieve before being placed in the machine. The minimum mixing time for each batch shall not be less that 1-1/2 minutes after the sand and cement are in the drum when the drum rotates at a peripheral speed of two-hundred (200) feet per minute. Completely discharge each batch before recharging. Clean the mixer at regular intervals to remove all adherent material from the mixing vanes and from the drum. No water shall be added to the mix after mixing and before application. Discard any mixed material which has exceeded the forty-five (45) minute maximum time to placement.

PART 3 - EXECUTION

3.01 PREPARATION

A. General. Mix concrete only in quantities for immediate use and discard any concrete which has set or is not completely discharged at the site within the maximum time allowed for placement. Retempering of any set concrete is strictly prohibited. When concrete arrived at the project with a slump below that specified, water may be added only if neither the maximum permissible water-cement ratio or the maximum slump is exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required.

B. Notification. The placement of concrete without the knowledge of the Engineer is strictly prohibited. The Contractor shall notify the Engineer a minimum of twenty-four (24) hours before placing concrete.

C. Protection from Adverse Weather. Unless adequate protection is provided, do not place concrete during rain, sleet, snow or freezing weather. Do not permit rainwater to increase the amount of mixing water or to damage the surface finish. If rainfall occurs after placing operations begin, provide adequate covering to protect the work from any adverse damage.

D. Placing Temperatures. All concrete shall be placed in accordance with the following provisions:

1. Cold Weather Placement. Unless special provisions are made for heating the concrete mix and the concrete in forms, do not place any concrete when the air temperature is below 40° F or is predicted to be below 40° F within forty-eight (48) hours of placement.
2. Hot Weather Placement. When the air temperature is above 85°F, use an approved retarding agent in all concrete. Concrete temperature prior to placement shall not exceed 95° F.

E. Maximum Time to Placement. Any concrete that has attained its initial set or has contained its mixing water or cement for more than forty-five (45) minutes shall not be placed in the work. The addition of an approved retarding agent may be proposed by the Contractor to increase the maximum time to placement. The increase of time to placement shall be proposed the Contractor and approved by the Engineer when the design mix is submitted for approval.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Placement of Concrete. The placement of concrete shall be in accordance with the following procedures:

1. Normal Weight Structural Concrete. Place concrete only upon a subgrade or surface acceptable to the Engineer. All forms shall be clean of dirt, and other construction debris, and all water shall be removed or drained from the forms before concrete is placed. Concrete shall be handled from mixer to transport vehicle to final place of deposition in a continuous manner and as rapidly as possible without segregation or loss of ingredients until the approved unit of operation is completed. Placing will not be permitted when, in the opinion of the Engineer, the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Forms or reinforcement shall not be splashed with concrete in advance of pouring. Concrete shall be deposited in uniform layers and as close as practicable to its final position. Immediately after placing, concrete shall be compacted and consolidated by vibration, spading, rodding, or forking such that the concrete is worked around reinforcement, embedded items and into the corners of the forms. The method used to consolidate and compact concrete shall be done so as not to cause segregation of the concrete. Special care shall be taken in placing and spading concrete against forms and all the joints to prevent the formation of voids and honeycombs. Tapping or other external vibration of forms will not be permitted. Vibrators shall not be used to move concrete in the forms. Concrete shall not be placed on concrete which is sufficiently hard to cause the formation of seams and planes of weakness within the section. Concrete shall not be allowed to drop freely more than five (5) feet in unexposed work nor more than three (3) feet in exposed work. Where greater drops are required, a tremie or other acceptable

means shall be employed. The discharge of the tremies shall be controlled so that the concrete may be effectively compacted into horizontal layers not more that twelve (12) inches thick and the spacing of the tremies shall be such that cavities do not occur. Concrete to receive other construction shall be screeded to proper level to avoid excessive shimming or grouting.

2. Concrete Riprap. Place concrete on the slopes and other areas to be protected as shown on the plan details and as acceptable to by the Engineer. All surfaces shall be moist when the concrete is placed. If the surfaces are dry and not consolidated properly, the Engineer may require the entire area to be sprinkled or sprinkled and consolidated before the concrete is placed. After the concrete has been placed, compacted and shaped to conform to the dimensions shown on the Drawings and after it has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to secure a reasonably smooth surface. Concrete riprap which is pneumatically placed shall conform to the requirements of subparagraph 3 "Pneumatically Placed Concrete."

3. Pneumatically Placed Concrete. The compressor or blower used to supply air for placing concrete shall be capable of delivering a sufficient volume at a pressure range of thirty (30) to sixty (60) pounds per square inch (psi) as required by the size of the nozzle being used. When a hose length of one-hundred (100) feet is used, the pneumatic pressure at the nozzle shall be forty-five (45) pounds per square inch (psi), or more, as necessary to efficiently prosecute the work. For lengths over one-hundred (100) feet, the pressure shall be increased five (5) pounds per square inch (psi) for each additional fifty (50) feet of hose required. Steady pressure must be maintained throughout the placing process. The water pump shall be of sufficient size and capacity to deliver the water to the nozzle at a pressure of not less than fifteen (15) pounds per square inch (psi) in excess of the required air pressure. Proper consistency of the concrete shall be controlled at the nozzle valve by the operator and a low water-cement ratio must be maintained. The mix shall be sufficiently wet to properly adhere and sufficiently dry so that it will not sag or fall from vertical or inclined surfaces or separate in horizontal work. In covering vertical or inclined surfaces, placing of the concrete shall begin at the bottom and be completed at the top. The nozzle shall be held at such distance (2 to 4 feet) and position that the stream of flowing concrete shall impinge as nearly as possible at right angles to the surface being covered. Any deposit of loose sand shall be removed prior to placing any original or succeeding layers of pneumatically placed concrete. Should any deposit of loose sand be covered with pneumatically placed concrete, the concrete shall be removed and replaced with a new coat of pneumatically placed concrete after the receiving surface has been properly cleaned. Before channel lining or riprap is placed, the slopes shall be thoroughly and uniformly consolidated and moistened. Sprinkling or sprinkling and consolidation may be required by the Engineer before placement of concrete. The subgrade for lining shall be excavated and fine graded to

the required section. The use of forms for lining will not be required. The surfaces of pneumatically placed concrete for both channel lining and riprap shall be accurately finished by hand floating methods before the concrete has attained its initial set. The original surface and each surface which is permitted to harden before applying succeeding layers shall be washed with water and blasted with air, or a stiff hose stream, and all loosened material removed. Sand which rebounds and does not fall clear of the work or which collects on horizontal surfaces shall be blown off from time to time to avoid leaving sand pockets. Rebound which is recovered and is clean and free of foreign matter may be reused as sand in a quantity not to exceed twenty (20) percent of the total sand requirement. Pneumatically placed concrete shall not be applied to a surface containing frost or ice. Where standing or running water is encountered, it shall be removed before pneumatically applying the concrete. Only experienced foremen, gunmen, nozzlemen, and rodmen shall be employed and satisfactory written evidence of such experience shall be furnished to the Engineer upon request.

B. Surface Finish on Concrete.

1. Monolithic Slab Finishes.
    a. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
    b. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete sidewalks, platforms, steps, and elsewhere as indicated.
        (1) Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
2. Concrete Surface Uniformity: The concrete surface shall not vary from the design slope by more than 0.5% in any 4-foot-long segment.
3. Finishing Formed Surfaces.
    a. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch (6 mm) in height rubbed down or chipped off.
    b. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or if it is specified to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with

selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

c. Smooth-Rubbed Finish: Not later than one day after form removal, provide smooth-rubbed finish on concrete surfaces that have received smooth-formed surface but are not specified to be coated or covered.

(1) Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

C. Curing of Concrete.

1. Moist Curing. All freshly placed concrete shall be cured by keeping the exposed surfaces, edges and corners continuously moist for a minimum duration of seven (7) days by spraying, ponding or covering with waterproof paper, polyethylene film or wet burlap. The temperature of the concrete shall maintained above 50° F for the seven (7) day curing period. All materials for protecting and curing the concrete shall be on hand and ready for use before concreting begins. Wood forms left in place will not be considered adequate for moist curing. Ceilings and inside walls may be cured by leaving the forms on for at least four (4) days.

2. Curing Compound. In lieu of moist curing, a curing compound which is acceptable to the Engineer as to color, quality, and moisture retention, may be used. Apply curing compound in accordance with manufacturer's instructions.

3.03 FIELD QUALITY CONTROL

A. General. The Owner shall obtain the services of an independent qualified testing laboratory to perform the required testing and inspection of the concrete. All construction materials necessary for tests shall be provided by the Contractor at no additional expense to the Owner or the testing laboratory.

B. Slump Test. Contractor shall perform slump tests on each batch of concrete delivered to the job site. Slump tests shall be performed under the guidance and supervision of the testing laboratory representative and/or Engineer. The maximum permissible slump for concrete prior to addition of water reducing agents shall be as follows:

Location of Concrete	Maximum Slump (in.)
Reinforced foundation walls and footings	5"
Plain footings and piers	5"
Slabs, beams and reinforced walls	5"
Pavements	4"

C. Water reducing admixtures (plasticizer) may be added as allowed by the concrete producer after the initial slump test. The maximum slump after adding water reducing admixtures shall be 8".

D. Field Test Cylinders. The testing laboratory shall prepare one (1) set of concrete test cylinders, consisting of a minimum of three (3) cylinders, for each one-hundred (100) cubic yards (CY) of concrete pour or major fraction thereof. If the quantity of concrete poured in a day is less than one-hundred (100) cubic yards (CY), one (1) set of concrete tests cylinders is required. Each concrete test cylinder shall be made in accordance with the provisions outlined in ASTM C31. Test cylinders shall be cured under laboratory conditions except when, in the opinion of the Engineer, prevailing job site conditions necessitate cylinders be cured under job conditions. Testing of concrete test cylinders shall be done by the testing laboratory in accordance with the provisions outlined in ASTM C39. One (1) cylinder shall be tested for compressive strength at the age of seven (7) days and a minimum of one (1) cylinder shall be tested for compressive strength at the age of twenty-eight (28) days. If any cylinder test is below the specified strength requirements, the Engineer shall have the right to require changes in the mix design, require additional curing time, change the batching process, or take other necessary actions so that the concrete being placed in the work will meet the specified strength requirements.

3.04 ADJUSTING / CLEANING

A. All tie holes and other surface defects shall be repaired immediately after form removal. Approved patching grout shall be used to fill the minor voids left by form ties and all protruding defects left by forms shall be removed with a rubbing stone.

END OF SECTION 03 30 54

SECTION 03 35 36 - POLISHED CONCRETE FLOOR FINISHING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: Products and procedures for placement, finishing, and polishing cast-in-place concrete floors, to be installed by a Manufacturer Certified Applicator.
   1. Interior dyed polished concrete floors.
   2. Joint sealants for polished concrete floors.

B. Note: Initial grinding to 400 grit shall occur prior to wall framing to obtain a uniform appearance along wall edges.

C. Related Sections include the following:
   1. Division 03, Section "Cast-in-Place Concrete", and other Sections related to floor slab placement and finishing.

1.03 REFERENCES

A. ASTM C 779 - Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.

B. ASTM C 1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method; 1996.

C. ASTM G23-96 - Standard Practice for Operating Light - Exposure Apparatus (Carbon-Arc Type) with and without Water Exposure of Nonmetallic Materials.

D. ASTM C805 - Standard Test Method for Rebound Number of Hardened Concrete.

1.04 SUBMITTALS

A. Product Data: Manufacturer’s technical literature for each product indicated, specified, or required. Include manufacturer's technical data, application instructions, and recommendations.

B. Samples for Initial Selections:
   1. Manufacturer's color card for concrete dyes.

C. Samples for Verification: Submit 12 inch square samples of polished finish in each color, texture, and pattern specified, include not less than 3 in each sample set showing limits of variations expected for each color, texture, and pattern specified. Resubmit samples until approved.

D. Informational Submittals:
   1. Manufacturer's Certification.
   2. Applicator's Qualifications.
   3. Field Quality Control Reports:
      a. Submit Manufacturer's field quality control reports / recommendations for field visits as described by Field Quality Control article.
      b. Certification of coefficient of friction as required by Field Quality Control article.
   4. Concrete Producer's Qualifications.

E. Closeout Submittals: Maintenance Data: For inclusion in operation and maintenance manual required by Division 01. Include manufacturer's instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use. Include precautions against cleaning products and methods which may be detrimental to polished finishes and performance.

1.05 QUALITY ASSURANCE

A. Manufacturer's Quality Assurance: Submit manufacturer's certification that products comply with specified requirements and are suitable for intended application.

B. Applicator's Qualifications:
   1. Supervision: Maintain competent supervisor who is at Project during times specified Work is in progress, and, who is experienced in installing systems similar to type and scope required for Project.
   2. Manufacturer's Certification: Provide letter of certification from sealer/hardener manufacturer stating that the applicator is a certified applicator of the Manufacturer's polishing system and is familiar with proper procedures and installation requirements required by the manufacturer for diamond polishing.
   3. Experience: Company with not less than 5 years continuous experience under the current name in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce required Work.
   4. Upon request, submit list of a minimum of 5 completed projects of comparable or greater size and complexity to this Work. Include for each project:
      a. Project name and location.
      b. Name and contact information for Owner.
      c. Name and contact information of General Contractor (if applicable).
      d. Name and contact information of Architect.
      e. Name of Polished Concrete Floor Finish manufacturer.
      f. Approximate square footage of densified diamond polishing system installed.
      g. Date of completion.

C. Concrete Producer Qualifications: Firm experienced in manufacturing ready-mixed concrete products and that complies with following requirements for production facilities and equipment:
   1. ASTM C 94.
   2. NRMCA's Certification of Ready Mixed Concrete Production Facilities.

D. Static Coefficient of Friction: Products and polishing operations shall achieve following as determined by quality control testing according to NFSI 101-A:
   1. Level Floor Surfaces, typical: Minimum 0.6, dry, minimum 0.6 wet.
   2. Sloping Floor Surfaces: Minimum 0.8, dry.

E. Field Mock-up for Aesthetic Purposes: Before performing work of this Section, provide as many field samples as required to verify selections made under submittals and to demonstrate aesthetic effects of polished finish. Approval does not constitute approval of deviations from Contract Documents, unless such deviations are specifically approved by Architect in writing.
   1. Polish 5 foot square floor area for each polished finish type**.**
      a. When there is an appropriate area available, and if approved by Architect, mock-ups may be constructed on areas of floor slab not scheduled for polished concrete floor finish, provided that the mock-ups will be concealed by other flooring systems as scheduled, and the mock-up will not adversely affect the installation or performance of the scheduled flooring system for that area. Confirm available locations for such mock-ups prior to pouring slabs to be polished, with Architect and with installer(s) of

other flooring system(s). Otherwise, provide temporary minimum size 5'x5'x4" thick concrete pads for mock-ups, poured at same time and of same material as the concrete floor slabs to be polished.

2. Use the same personnel, including supervisors, which will perform the Work.
3. Install products and materials according to specified requirements and same installation procedures to be used in installation of the Work.
4. Work shall be representative of those to be expected for the Work.
5. Show maximum variation that will be expected to exist in the completed Work.
   a. If there is cracking evident in floor slabs to be polished at time of polishing mock-ups, include crack repair examples in the initial mockups.
   b. Provide mockups for all surface imperfections or surface damage repairs evident in the slab as directed by Architect, at the time that such conditions are observed to exist. It is the intent of these specifications that all surface imperfections in all areas of polished concrete floor finish will be patched as part of the base scope of the work, whether or not the surface imperfections are caused by non-conforming work. Architect shall have discretion to determine which types of surface imperfections will or will not be patched based on results of mockup reviews.
6. Approval is for the following aesthetic qualities:
   a. Compliance with approved submittals.
   b. Uniformity or intended effect of exposed aggregate.
   c. Uniformity of sheen.
7. Obtain Architect's approval before starting work on Project.
8. Maintain field mock-ups during construction in an undisturbed condition as a standard for judging completed Work.
9. Do not demolish, alter, or remove field mock-ups until acceptable to Owner and Architect.
10. When directed, demolish and remove field mock-ups from Project.

F. Pre-Installation Conference: Prior to placing concrete for areas scheduled for polished concrete floor finish, conduct conference at Project to comply with requirements of applicable Division 01 Sections.
   1. Required Attendees:
      a. Owner's representative.
      b. Architect.
      c. General Contractor, including superintendent for this project.
      d. Concrete Floor Polishing System Applicator, including the supervisor for this project.
      e. Concrete Floor Polishing System Manufacturer's field representative.
   2. Minimum Agenda: Floor Polishing System Applicator, and other related trades as applicable, shall demonstrate understanding of work required by reviewing and discussing procedures for, but not limited to, following:
      a. Discuss and evaluate compliance with Contract Documents, including substrate conditions, surface preparations, sequence of installation and other preparatory Work performed by other installers.
      b. Review approved submittals.
      c. Review installation procedures, including, but not limited to:
         1) Environmental requirements.
         2) Curing methods.
         3) Surface preparation.
         4) Repair Procedures.
         5) Field quality control procedures and requirements.
         6) Cleaning.
         7) Protection of systems.

8) Coordination with other work.
9) Maintenance.

3. Minutes: General Contractor shall record discussions, including decisions and agreements reached, and furnish copy of minutes to each party attending.

G. Field Quality Control Conferences: Should deficiencies or complications arise requiring a field quality control conference with the Polishing System Manufacturer's Representative, conduct a field quality control conference with adequate notice to same attendees as the Pre-Installation Conference.

1. Tour mock-ups and representative areas of required work. Discuss and evaluate corrective actions required for compliance with Contract Documents, including substrate conditions, surface preparations, sequence of installation and other repair or preparatory Work performed by polishing system Applicator or other trades.
2. Manufacturer's field representative shall prepare and issue report to attendees noting decisions made, and follow-up actions and corrective actions required.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original, factory sealed, unopened, new containers bearing manufacturer's name and label intact and legible.

B. Store materials in protected and well ventilated area at temperatures between 40° and 90° degrees F., unless otherwise required by manufacturer. Keep containers sealed until ready for use. Do not use materials beyond manufacturer’s shelf life limits. Protect materials during handling and application to prevent damage or contamination.

1.07 PROJECT CONDITIONS

A. Damage and Stain Prevention: Take precautions to prevent damage and staining of concrete surfaces to be polished.

1. Prohibit following over concrete surfaces to be polished:
   a. Vehicle parking.
   b. Pipe cutting operations.
   c. Ferrous metals storage.
2. Protect concrete surfaces to be polished from following:
   a. Petroleum, oil, hydraulic fluid, or other liquid dripping from equipment.
   b. Acids and acidic detergents.
   c. Painting activities.

B. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting polishing operations.

1.08 WARRANTY

A. Sealer/Hardener: Manufacturer's Standard Ten (10) year material warranty and Certified Applicator’s Ten (10) year labor warranty for Sealer/Hardener, Jointly signed.

1.09 MAINTENANCE MATERIALS

A. At end of project, provide Owner with five gallons of RetroPlate’s CreteClean Plus, or Manufacturer's recommended cleaning product, and latest published Maintenance brochure for proper maintenance.

PART 2 - PRODUCTS

2.01 MANUFACTURER AND PRODUCTS

A. Available Manufacturers and Products: Subject to compliance with requirements of Contract Documents, manufacturers offering products that may be incorporated into Work include, but are not limited to, those listed alphabetically below.

B. Basis of Design: Contract Documents are based on products as manufactured by RetroPlate, (888) 942-3144, www.retroplatesystem.com, to establish a standard of quality. Other available products and installation processes having equivalent characteristics and quality control may be considered, provided deviations are minor and does not change concept expressed in Contract Documents as judged by Architect.
   1. Penetrating Concrete Sealer / Hardener: Advanced Floor Products, Provo UT.
   2. Polish Guard, water based copolymer for forced burnishing application: RetroPlate "RetroGuard", or Floor Polishing System Manufacturer's approved equal product.
      a. At Apparatus Bay, use polish guard product designed to resist oil spills, Retro-Pel or approved equal product.
   3. Joint Sealant: Curecrete Chemical Company, Springville, UT.
   4. Contact: Rhonda Clinton, PSI Permanent Surfaces, 214-522-4047.

2.02 [CONCRETE MATERIALS]

A. Cementitious Materials: As specified in appropriate Division 03 Section.

B. Normal-Weight Aggregates:
   1. Description:
      a. ASTM C 33, Per Division 03, Section “Cast-In-Place Concrete.”
      b. Selected, hard, and durable gravel; free of material that reacts with cement or causes staining.
      c. Uniformly or gap graded to match approved sample.
      d. From single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

C. Decorative Aggregate: Per Division 03, Section “Cast-In-Place Concrete.”

D. Water: ASTM C 94 and potable.

E. Admixtures: As specified in appropriate Division 03 Section.

2.03 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd.

B. Water: Potable; applied periodically in mist or fine spray as required in hot or dry weather to keep surface damp during curing, to minimize likelihood of shrinkage cracking and similar imperfections.

C. Curing agents can leave a film on concrete or react with free lime and cause failure of concrete floor polishing to achieve desired results. Do NOT use any chemical curing agents unless specifically approved in writing by Architect and Concrete Floor Polishing System Manufacturer.

2.04 PENETRATING CONCRETE SEALER/HARDENER

A. "RetroPlate 99 Polishing System", or approved equal. Formulated to seal, dustproof, increase abrasion resistance and develop polished appearance to concrete surfaces to which it is applied.
   1. Description: Clear liquid form of sodium silicate to permanently seal, dustproof and harden concrete surfaces and provide abrasion resistance by penetrating into concrete

pores and chemically reacting. Chemically relies on an internal reaction, leaving no surface film or residue to densify pores. Products containing silicanates, magnesium florasilicates, or potassium silicates **[or lithium silicates]** will not be acceptable and will not be approved. Products must conform and meet minimum performance characteristics as described herein.

2. Performance Criteria:
   a. Abrasion resistance: ASTM C779 - Up to 400% increase in abrasion resistance.
   b. Impact Strength: ASTM C805 – 21% increase impact strength.
   c. Ultra Violet Light and Water Spray: ASTM G23-81 – No adverse effect to ultra violet and water spray.
   d. Coefficient of Friction: ASTM C1028 – Meet or exceed OSHA and ADA recommendations.
   e. Reflectivity: IG – 310 Gloss Reader Checker – up to 30% increase in reflectivity.
   f. Densification: Achieve waterproofing, hardening, dustproofing, and abrasion resistance of the concrete surfaces while imparting specified sheen.

B. Manufacturer's Technical Representative available to make site visits.

C. RetroPlate System Schedule:
   1. Polished Concrete**,** (PC) – RetroPlate 99 Polishing System applied to natural Gray Concrete. Spiff coats: 2 coats of Retro Guard.
      a. Level of Grinding: Medium Grind / Salt and Pepper Finish
      b. Sheen: Level I Matte Sheen 400 Grit.
      c. Color: Natural polished concrete.

2.05 JOINT SEALANT , SPALL, AND CRACK REPAIR

A. Crack Repair and Joint Sealant products must meet specification requirements for compatibility with Diamond Polished Concrete Floor Finish System as recommended by manufacturer of concrete sealer/hardener. The following products named are for RetroPlate system and to set quality standard.

B. Joint Filler / Sealer: Polishing system Manufacturer's recommended self-leveling elastomer joint filler, "CreteFill Pro Series" as manufactured by Curecrete of Springville, Utah, or approved equal.
   1. ASTM D-2240, Shore A hardness.
   2. Rated for heavy vehicle traffic.
   3. Resistant to petrochemicals.
   4. Remains flexible, including in cold temperatures.
   5. Color: Standard Gray at natural (un-dyed) polished concrete

C. Spall and Crack Repair for concrete patching: Polishing system Manufacturer's recommended high strength, hybrid urethane repair material, "CreteFill Crack Repair" and "CreteFill Spall Repair", as manufactured by Curecrete of Springville, Utah, or approved equal.
   1. Can be color-matched to adjacent concrete.

2.06 ACCESSORIES

A. General: Accessories required for application of Colored Concrete Dye and Diamond Polishing System: Provide in accordance with floor finish system Manufacturer's instructions, including thinners.

B. Neutralizing Agent:
   1. Trisodium Phosphate.
   2. Ammonia.

C. Water: Potable.

D. Protective Covers: Use protective covers approved by Concrete Floor Polishing System Manufacturer. Do not use coverings that are impermeable or would trap moisture in or on the slab surface.

1. Sheet Protection Membrane: Water Vapor Permeable, breathable membrane. McTech Group "EZ-Cover" Builder's Site Protection, Inc. "SurfacePro" Surface Liner USA "Surface Liner Vapor", or approved equal**.**
   a. Provide seam and perimeter tapes of type as recommended by Manufacturer. Adhesives integral to or used as part of the membrane protection system shall be designed to release from the slab without staining or leaving a residue. Other tapes shall not be applied to the concrete slab.
2. Plywood: Nominal 1/2" over Kraft Paper (see below)
3. Kraft Paper: Non-marking construction Kraft Paper, with tape for seams as required. Tape shall not be applied directly to concrete slabs. Overlap Kraft Paper a minimum of 6" at each seam before taping.

2.07 MIXING AND TINTING

A. Do not thin sealer/hardener.

B. Mix colored concrete dye in strict accordance with AmeriPolish Dye manufacturer's instructions.

C. Do not use material beyond manufacturer's recommended pot life.

2.08 POLISHING EQUIPMENT

A. Field Grinding and Polishing Equipment:
1. Variable speed, 3 or 4 head counter-rotating, walk-behind machine with not less than 600 lbs of down pressure on grinding or polishing pads.
2. Dust extraction equipment with flow rate suitable for dust generated, with pre-separator and squeegee attachments.
3. At slabs with questionable flatness level, use grinding equipment with rotating heads, to minimize uneven aggregate exposure patterns.

B. Edge Grinding and Polishing Equipment: Hand-held or single head walk-behind machines which produces same results, without noticeable differences, as field grinding and polishing equipment.

C. Burnishing Equipment: Single head high speed walk-behind machines.

D. Grinding Pads: Metal bonded pads with embedded industrial grade diamonds of varying grits fabricated for mounting on equipment.

E. Polishing Pads: Resin bonded pads with embedded industrial grade diamonds of varying grits fabricated for mounting on equipment.

F. Burnishing Pads: Maintenance pads coated with embedded industrial grade diamonds for use with burnishing equipment.

2.09 CONCRETE MIX DESIGN

A. Material Quality Standards: Mix designs for each type and strength of concrete used for floors will be prepared as specified in appropriate Division 03 Section, with following qualifications:
1. Slump Limit: 4 inches, plus or minus 1 inch.
2. Maximum Water-Cement Ration: 0.45.

3. Air Content: No air entrainment permitted.
4. Admixtures: Calcium chloride based compounds not permitted.

PART 3 - EXECUTION

3.01 PLACING AND FINISHING CONCRETE FOR FLOORS

A. General: Comply with appropriate Division 03 Section.

B. Hot and Cold Weather Placement: As specified in appropriate Division 03 Section.

C. Placement: Deposit and consolidate concrete in continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Screed slab surfaces with a straightedge and strike off to correct elevations.
3. After screeding, consolidating and leveling, do not work surface until ready for floating.

D. Float Finishing:
1. Begin floating operations when water sheen has disappeared, and/or when concrete has stiffened sufficiently to permit proper operation of power-driven equipment.
2. Consolidate surface with power-driven troweling using steel float pans.
3. Hand float with wood or cork faced floats in locations inaccessible to power-driven machine.
4. Level surface using 10 foot highway straightedge.
5. Cut down high spots and fill low spots to produce planes checking true under straightedge in any direction.
6. Bring surface to uniform, smooth, granular texture with power-driven troweling using steel float pans.

E. Floor Flatness & Floor Levelness: F(F) 40 and F(L) 35 according to ASTM E 1155.
1. Minimum floor flatness Local Limits are the same as above.
2. Where different floor flatness limits are indicated in Structural Drawings or other concrete specification Sections, the most stringent flatness requirement shall apply for polished concrete slabs.

F. Joints: Saw cut or tool joints to match approved mock-up.

G. Column Leave-Outs:
1. Wherever column leave-outs will be exposed in the finished polished concrete work, do not tool joints.
2. Pour leave-outs with same mix design concrete as the adjacent slab and fill flush to 1/32" above adjacent slab.
3. Feather thinly out over edge of the slab; the feathered edge to be removed by the grinding process to produce a smooth transition with no joint line.

H. Moisture Curing:
1. Immediately begin after floating.
2. Keep concrete surface continuously wet by covering with absorptive cover or by using continuous water-fog spray.
3. Cover concrete surface with absorptive cover with 4 inch lap over adjacent absorptive covers.
4. Thoroughly saturate cover with water and keep continuously wet.
5. Curing compounds will only be considered where product is chemically compatible with the polishing products to be used and is specifically pre-approved in writing by the polishing system Manufacturer.

3.02 EXAMINATION

A. Refer to Protection article for protection requirements.

B. Acceptance of Surfaces and Conditions: Examine substrates to be polished for compliance with requirements and other conditions affecting performance. If substrate preparation is the responsibility of another installer, notify General Contractor of unsatisfactory preparation before proceeding. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting Work within a particular area will be construed as acceptance of surface conditions.

C. Substrate limitations:
   1. Allow new concrete to cure a minimum of 21 days before starting initial grind.
   2. Allow new concrete to cure a minimum 45 days at 75 degrees prior to application of Polished Concrete Floor Finish. All new concrete to receive Colored Concrete Dye colors must be cured with curing methods as recommended by Manufacturer of Polished Concrete Floor System. Verify compatibility prior to application of curing.
   3. Verify that sub-floor surfaces are smooth and flat within tolerances specified in Section 03300 and are ready to receive Polished Concrete Floor Finish. Verify that the concrete floor is a minimum Flatness of 40 and Levelness of 35.
   4. Apply Polished Concrete Floor Finish minimum 15 days prior to installation of baseboard, equipment and prior to substantial completion.
   5. Notify Architect or Owner's Representative of any pre-existing conditions upon removal of floor coverings, if any unforeseen problems occur prior to proceeding with Polished Concrete Floor Finish. Once work has commenced, the Applicator accepts full responsibility of the outcome of the floor.

3.03 SURFACE PREPARATION OF CONCRETE FLOORS

A. General:
   1. Remove curing, sealing and coating agents, floor coverings**,** mastic, oil, breaking compound residue, any surface contaminants, wax and grease by mechanically or chemically removing; to remove all surface contaminants and to assure penetration of product into surface. Remove mildew by scrubbing with solution of trisodium phosphate and bleach. Rinse with clean water. All concrete surfaces receiving Polished Concrete Finish shall be properly neutralized prior to applying densifier to prevent cross contamination and whiting.
   2. Remove dust and loose material by brushing, sweeping, vacuuming, and blowing with high pressure air.
   3. Remove paint residue with solvent/stripper provided the stripper does not have an acidic pH.
   4. Remove tire marks or any residue that will affect the appearance of the floor. Do not seal in any contaminants.
   5. Power scrub and rinse entire floor surface to thoroughly rinse and remove all soap residue or contaminants. Squeegee dry.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, visible staining and all other foreign contaminants.

C. Protect surrounding and adjacent surfaces in manner recommended by Polished Concrete Stain Finish manufacturer. Do Not contaminant or Damage equipment, furniture or adjacent, surrounding surfaces with equipment, Concrete Dye stain, or Sealer/Hardener. Any damage that occurs as a result of poor workmanship shall be replaced and/or repaired by the Certified Applicator and installers.

D. Begin initial grinding while the concrete slab is wide open, prior to wall installation and the building is dried in. Coordinate general contractor and with other trades. Aggregate exposure shall be kept to a minimum unless otherwise authorized and approved by Architect or Owner's Representative. Grind to 400 Grit. Complete Polished Concrete Floor Finish installation at the end of the project, nearing completion. Polish concrete floor surfaces with power disc machine; sequence with coarse grit to fine abrasive. Utilize manufacturer's recommended equipment and polishing diamonds for installation of specified floor system using Manufacturer's seven step diamond polishing process. Apply concrete dye in the correct sequence with Manufacturer's installation instructions.

E. All interior exposed concrete surfaces to receive Polished Concrete Floor Finish shall have RetroGuard spiff coats, or Manufacturer's equivalent.

F. Fill joints and use joint filler, spall and crack repair materials in strict accordance with manufacturer's guidelines. Install and coordinate in proper sequence with polishing system specified herein.

G. Treating Surface Imperfections:
   1. Prepare and clean patch areas according to Repair Material and Polishing System Manufacturers' instructions.
   2. Mix patching compound and grout material with dust created by grinding operations to match color of adjacent concrete surface (or other color match process as recommended by repair materials Manufacturer and approved by polishing system Manufacturer and Architect).
   3. Fill surface imperfections including, but not limited to, holes, surface damage, small and micro cracks and surface cracks, air holes, pop-outs, spalls, and other voids.
   4. Work compound and treatment until color differences between concrete surface and filled surface imperfections are not noticeable.

H. Grout and Repair Grinding:
   1. Repair and grind concrete surfaces in proper sequence according to Polishing System Manufacturer's recommendations.
   2. Use grinding equipment and appropriate grit grinding pads, matching floor polishing system or otherwise in accordance with Polishing System Manufacturer's recommendations.
   3. While applying fresh grout material prior to final polishing, grind concrete in direction perpendicular to initial grinding as required to remove scratches and leave consistent pattern ready for final polish grinding.
   4. Vacuum floor using squeegee vacuum attachment.

I. Grind protrusions flush with surface. Patch voids, holes and cracks with recommended spall and crack repair patching compound that is compatible with sealer/hardener, concrete dye and Polished Concrete Floor Finish as specified herein.

3.04 DECORATIVE CUT JOINTS, PATTERNS [AND GRAPHICS]

A. Saw cut and route decorative joints in accordance with Division 03, Section "Cast-In-Place Concrete", using types of saw/blades indicated and within time limits indicated.

B. Use concrete saw cutting equipment with fine diamond blade approved by sealer/hardener manufacturer. Sawcuts shall be clean and with sharp edges. Do not allow saw cuts to run out beyond intended sawcut pattern outlines. Jagged edges or gouges shall be patched and repaired as is deemed necessary by the Architect or Owner's Representative.

3.05 CONCRETE POLISHING APPLICATION

A. Initial Grinding: Polished Concrete Floor Finishes shall be taken to a 400 grit prior to the walls being installed while the slab is wide open and dried in. Grind concrete to specified aggregate exposure imparting uniform scratch pattern in concrete. Vacuum floor using squeegee vacuum attachment.
   1. Surface grind / Cream finish: Minimal grind to achieve polish level, producing cream finish with minimal aggregate exposed.
   2. Medium Grind / Salt and Pepper Finish: Medium grind to achieve even level of aggregate exposure across the floor surface, producing a mix of cream and aggregate exposure to salt and pepper effect as approved by mockup review.
   3. Deep grind / large exposed aggregate: Deep grind to achieve even level of exposure of larger aggregate across the floor surface, to desired effect as approved by mockup review.

B. General:
   1. Apply sealer/hardener and colored concrete dye with application equipment and polishing diamonds as recommended by Polished Concrete Floor Finish manufacturer for each system scheduled herein.
   2. Manufacturer's Certified Applicator to install specified polishing system in strict accordance with manufacturer's recommended polishing grits for each intended sequence to achieve the Polishing System, and specified level of sheen. Manufacturer's same Certified Applicator shall install concrete dye when used in conjunction with the Polishing System.
   3. Contact Manufacturer's Technical Director or Owner's Representative with any questions.
   4. Comply with recommendations of product manufactured for drying time between succeeding coats.
   5. Recoat dyed and sealed floors where there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat free of other defects due to insufficient sealing or dying.
   6. Remove Polished Concrete Floor Finish defects due to poor workmanship, visible and unacceptable to Manufacturer's Representative, Architect or Owner's Representative and RE-install to achieve satisfactory results.
   7. Make edges of Polished Concrete Floor Finishes adjoining other materials clean and sharp. Make edges of Colored Concrete Dyes clean and sharp with no overlapping. Work materials and Concrete Dyes into surface voids and cracks. Detail the edges located at the base of the wall, around corners, adjacent surfaces, and all horizontal floor surfaces to match Polished Concrete Floor Finishes to provide a uniform finish to include Polished Concrete Floor Finish, color and sheen per the Approved Mock-Up..
   8. Do Not Apply Tape to Polished Concrete Finish as this will damage or etch surface and the entire system will have to be Re-Done.
   9. Begin grinding and polishing with Polished Concrete Floor Finishes Manufacturer's recommended coarse diamond grit in uniform manner and proceed to next level of polishing diamond grit sequence to complete the Polishing System to match Approved Mock-Up for Aggregate exposure, Polished Concrete Floor Finish, Color, and Sheen.
   10. Complete all work in accordance with the Contract Documents.

C. Apply two coats of Colored Dye after recommended level of polish has been achieved. Apply in strict accordance with Manufacturer's application manual for adding color to the Polishing System and adhering to recommended sequence of diamond polishing. Additional coats may be necessary to achieve approved and acceptable color. Allow proper curing time between coats as recommended by the manufacturer of Colored Concrete Dye. Repeat if

Colored Concrete Dye does not react and adhere to substrate. Repeat until approved Mock-up color is achieved.

D. Completely clean and buff Dye residue as recommended by Polishing System Manufacturer's representative before proceeding with liquid densifier. Contact Manufacturer's Technical Director if any questions arise before proceeding with the next step. Check surfaces to determine that the Colored Concrete Dye Stain is adhering, is uniform, and consistent in color before proceeding with Sealer/Hardener. If whiting occurs, remove and Repeat steps.

E. First Coat: liquid Sealer/Hardener applied at approximately 200 SF per gallon applied to new and existing cured concrete. Applied and used in conjunction with Polished Concrete Floor Finishes. Applied in strict accordance with Manufacturer's latest published instructions for each intended floor finish and surface.

F. Polishing Steps:
   1. Polish to provide indicated level of sheen and finish.
      a. Level I Matte Sheen: 400 grit and as required to achieve uniform sheen to match approved mock-up.
      b. Level II Waxed Sheen: 800 grit and as required to achieve uniform sheen to match approved mock-up.
   2. Thin and apply as recommended by Manufacturer and apply 2 coats of RetroGuard, or Polishing System Manufacturer's equal product, allowing adequate curing time between coats.
   3. Burnish each coat, heating to a minimum of 90 degrees, with high speed propane burnisher capable of 2,600 rpm's, equipped with manufacturer's recommended burnishing pads. Twister Pads shall be used to complete Polished Concrete Floor Finish using appropriate grit for each intended level of sheen specified herein.

3.06 FIELD QUALITY CONTROL

A. Static Coefficient of Friction Testing: Retain Walkway Auditor to test polished finishes according to NFSI 101-A to confirm compliance with specified static coefficient of friction.

B. Manufacturer's Field Services: Manufacturer's representative to be available to provide technical assistance and guidance for surface preparation and application of floor finish system when assistance is requested. (Refer to Quality Assurance article in Part 1 of these specifications).
   1. Pre-Construction Conference.
   2. Field Visits as may be requested by Polishing System Applicator.
   3. Quality Control Conferences to address specific issues encountered, should a conference be deemed necessary by Manufacturer's Representative, Applicator, General Contractor, Architect, or Owner's Representative.

3.07 PROTECTION

A. Protect concrete floors to be polished before initial grinding and until final polishing operations, as required to prevent grease, oil, and other contaminants that would adversely affect floor polishing results. Do not allow lifts, wheeled vehicles, or other equipment that could leak oil or other chemicals, over slabs to be polished without protection in place.
   1. **Install approved membrane floor protection covering continuously over concrete area to be polished according to Manufacturer's installation instructions as soon as possible after initial grinding operations are complete, but not sooner than 21 days after concrete pour, or longer where recommended by membrane protection product manufacturer or polishing system Manufacturer**.
      a. In the event that the project schedule does not allow membrane installation before proceeding with other work over the slab, temporarily install untreated plywood over

taped kraft paper, or other approved temporary protection measure until application of protection membrane.

2. Install plywood protection board continuously over membrane floor protection as soon as possible after polishing operations. Remove and replace warped material upon building dry-in and when protection board becomes warped to the point that construction traffic over warped boards may damage protection membrane or the concrete slab.
   a. Where there is no protection membrane below plywood, install a layer of taped Kraft paper below the plywood, taped at joints.
3. Diaper lifts and equipment to prevent oil, gas, and contaminants from staining slab.
4. Do not use tape or other adhesive attachments to secure floor protection to unfinished concrete slab unless Concrete Floor Polishing System Manufacturer and Installer approve use of the specific tape or products to be used.
5. Maintain and modify protective covers as may be required throughout construction until removed for final polishing operations.

B. Take care to avoid physical damage to floor slab from construction operations such as dropped tools or other heavy equipment**.**

C. Do not allow pipe cutting, storage of steel, or sharp objects, and other materials to come into direct contact with slab that will cause discoloration or staining to slab.
   1. Where pipe cutting over slab is unavoidable, provide plywood and other protection as required to prevent damage and staining of concrete surface.

D. General Contractor and Applicator shall prohibit traffic on Polished Concrete Finish (stained or non-stained) at times and durations according to Manufacturer's instructions. In each instance, Applicator shall confirm readiness of floor, including protection in place when required, before traffic is allowed to resume.
   1. Provide “Wet Paint” signs as required to protect newly-polished and sealed finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of polishing operations. Barricade areas to protect Concrete Floor Polishing System (stained or non-stained) until properly cured for traffic according to Manufacturer’s instructions and recommendations.
   2. Protect and Cover Concrete Floor Polishing System (stained or non-stained) with materials that are recommended by Manufacturer during construction to protect from damage and debris. Do not apply Tape to the Polished Concrete finish at any time. Protect with a breathable covering such as non-marking Kraft paper or equal as recommended by the Manufacturer.
   3. Protect and Cover only after Concrete Floor Polishing System (stained or non-stained) has fully cured and is ready to be covered.

E. Take extra precautions to protect Polished Concrete Floor Finish at any stage of the installation to produce the best possible results.

F. Protect finished Work with protective coverings, from subsequent construction activities posing risk of damage to finished floor.
   1. Where construction operations that could cause physical damage to polished floors will occur after polishing operations, install protection board over kraft paper that is adequate to protect against damage from dropped tools, lifts, equipment, and other applicable hazards.

3.08 REPAIRS

A. Refinish all work which has become damaged or defaced during the course of construction and leave all finishing in clean, neat, and perfect condition, acceptable to the Owner’s

Representative. Repair or replace all damaged materials directly attributable to work under this Section.

3.09 CLEANING AND ACCEPTANCE

A. Clean floor, and adjacent surfaces as required, prior to inspection using Manufacturer's recommended cleaners and methods.
   1. Touch-up and restore finish where damaged.
   2. Remove spilled, splashed or splattered finish material from all surfaces, as required.
   3. Do not mar surface finish or item being cleaned. Make necessary repairs to damaged surfaces caused by cleaning operation or installation of Polished Concrete Finish.
   4. Leave storage space clean and in good condition required for equivalent spaces in project.
   5. During progress of work, remove from project daily all discarded materials, rubbish, containers, etc.
   6. Do not permit the use of water or cleaning agents at any time on completed Polished Concrete Floor Finish until said period of time is acceptable to Manufacturer's Representative and surfaces have cured for a minimum of seven (7) days, or longer where recommended by Manufacturer.
   7. Contact Polished Concrete Floor Finish Manufacturer's Representative for detailed instructions.

B. Final acceptance of Polished Concrete Floor Finish and Sealer shall be based upon inspection by the Architect and Owner's Representative. Polished Concrete Floor Finish and Sealer falling below specified and/or scheduled finish and approved Mock-up shall be re-done as required without additional expense to the Owner.

C. Remove temporary mockup slabs after acceptance.

END OF SECTION 03 35 36

SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Mortar and grout.
   3. Steel reinforcing bars.
   4. Masonry joint reinforcement.
   5. Ties and anchors.
   6. Embedded flashing.
   7. Miscellaneous masonry accessories.
   8. Masonry-cell insulation.

B. Related Sections:
   1. Division 03 Section "Concrete Reinforcements."
   2. Division 05 Section "Structural Steel" for installing anchor sections of adjustable masonry anchors for connecting to structural-steel frame.
   3. Division 07 Section "Bituminous Dampproofing" for waterproofing applied to concrete unit masonry.
   4. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
   5. Division 07 Section "Joint Sealants."
   6. Division 09 Section "Painting."

1.03 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

1.05 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
   1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
   2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength.
   3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
   4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.
   5. Prism Test: For each type of construction required, according to ASTM C 1314.

1.06 SUBMITTALS & MOCK-UP PANEL

A. Division 01- “Submittal Procedures”.

B. Submit sample board of each brick color and/or type, and mortar batch showing full range of color.

C. Submit product literature on mortar color and waterproofing admixtures.

D. Construct minimum 6'-0" x 6'-0" mock-up panel of typical masonry wall at window, incorporating face brick, rowlock brick, window, and both CMU and metal stud wall backup in manner as used on project.

E. Provide range of 32 mortar colors for selection of one color by Architect.

F. Product Data: For each type of product indicated.

G. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

H. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

I. Qualification Data: For testing agency.

J. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include data on material properties material test reports substantiating compliance with requirements.
      b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Reinforcing bars.
   6. Joint reinforcement.
   7. Anchors, ties, and metal accessories.

K. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

L. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

M. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Build mockups for typical exterior and interior walls in sizes as indicated in drawings by full thickness, including face and backup wythes and accessories.
      a. Include a sealant-filled joint at least 16 inches long in each exterior wall mockup.
      b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening sized as indicated in drawings.
      c. Include through-wall flashing with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
      d. Include exterior stone cladding with weeps, anchors and mortar netting.
   3. Protect accepted mockups from the elements with weather-resistant membrane.
   4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
      a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
   5. Approved mockups may not become part of the completed Work.

F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

G. General: Masonry shall not commence until Architect has approved mock-up. Use mock-up as standard comparison for all masonry constructed of similar and/or same material. Mock-up is to remain until all masonry is completed and accepted by the Owner.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

F. Masonry work shall not be placed when there is any possibility of the water freezing before it has attained its initial set. In weather below freezing, all masonry units and mortar shall be heated. Walls which have frozen after making their initial set shall not be built upon until they have had sufficient time to make a proper set at temperatures above freezing.

G. All newly placed masonry shall be protected against damage from action of the elements and under no condition shall rain be allowed to fall on, drive against or flow down masonry surfaces until mortar has set a minimum of 12 hours. Tops of all walls shall be covered with a waterproof material at the end of each day.

H. During warm, dry weather, masonry shall be protected from drying too rapidly. Masonry surfaces shall be kept moist with water gently spraying the surface, covering work with burlap which is kept wet, or by other approved means. Such protection shall be continued until mortar has set for 3 days or until lowering temperatures or increased humidity in the air make such protection unnecessary.

PART 2 - PRODUCTS

2.01 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.02 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3750 psi.
   2. Density Classification: Normal weight.
   3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
   4. Exposed Faces: Provide color array with standard smooth face.

C. Concrete Block: Hollow load bearing block, nominal size detailed height x 16" x detailed thickness, conforming to ASTM C90, Type N-I, normal light weight, Grades standard aggregate and U.B.C. Standard 24-3, with a minimum compressive strength of 3750 psi. Units of same manufacturer throughout. Furnish sizes, shapes, and miscellaneous items shown or required to complete work. Standard smooth face "grey" concrete block exposed to exterior as veneer shall be sealed and shall have consistent, unmottled appearance.

2.03 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I. Provide natural color to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: Not allowed.

E. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

F. Aggregate for Grout: ASTM C 404.

G. Water: Potable.

H. Sand: ASTM C144, graduation as required by mortar additive manufacturer.

I. Water Repellent Admixture: Rheomix 235 by Master Builders or approved equal.

J. Workability Additive: "A" Marble Dust by Armco Steel Corp., 90/200 Mineral Filler by Limestone Products.

K. Mortar Color Additive: Light Buff color equal to Solomon Grid-Chem Services Inc.

2.04 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Exterior Walls: Hot-dip galvanized, carbon steel.
   3. Wire Size for Side Rods and Cross Rods: 9-Gauge.

4. Material shall be Dur-O-Wall DA 3200, Single Width Ladur.

C. Furnish and install steel reinforcement, maintaining minimum required clear distances.

D. Where detailed, install grout fully around steel reinforcement. Grouting done in lifts of 24" (for spaces less than 2" wide) and 48" (more than 2" wide). Agitate and puddle grout during and after placement. Exercise care to prevent grout from staining face of masonry. Immediately remove grout spillage on face and top of masonry.

E. Minimum compressive prism strength of the masonry (f'm) shall be 2500 psi when tested at 28 days.

2.05 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
   2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
   3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
   4. Stainless-Steel Sheet: ASTM A 666, [Type 304] [Type 316].
   5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   6. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

B. Adjustable Anchors. Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Masonry Wall Tab Anchors at CMU Wall Backup: A 4 inch hot-dip galvanized adjustable ladder tab for cavity installation equal to Wire Bond Series 600.
   2. Adjustable Veneer Anchors: Hot-dip galvanized wire anchors at 16 inches vertically and 16 inches horizontally at studs equal to Wire Bond No. 1004, Type III, secured with stainless steel screws. Triangular ties equal to Wire Bond No. 1100-5, typical.

C. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated. Minimum of 5/8” x 6”.

D. All CMU veneer/CMU backup walls shall be reinforced horizontally with reinforcing spaced 16" o.c. vertically, maximum. Lay reinforcing on wall and cover with mortar, then bed unit as herein specified. At corners, reinforcing is to be provided in every horizontal course, with inside rod cut and bent to form corner. Provide reinforcing one course above and below all openings. Reinforcement

placed as to assure a 5/8" mortar cover measured from the outside face of the joint. Side rods shall be lapped at least 14" at splices.

E. Intersecting and butting walls and partitions shall be bonded together by metal anchors spaced 2' - 0" o.c. vertically. Interlocking of units not permitted.

2.06 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual Division 07 Section "Sheet Metal Flashing and Trim".

B. Flexible Flashing (Through-Wall Flashing): Use the following unless otherwise indicated:
   1. Copper-Laminated Flashing: 3-oz./sq. ft .copper sheet bonded between 2 layers of glass-fiber cloth.
      a. Products: Subject to compliance with requirements, provide the following:
         1) York Manufacturing, Inc.; 3 oz. Multi Flash Series 500.

C. Cell Vent Weep Baffles: Install cell vent weeps in vertical joint of first course immediately above all flashings, weep spaces 24" O.C. Extruded polypropylene copolymer weeps equal to Wire Bond No. 3601. Color to be selected by Architect.

2.07 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from urethane.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-80 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Dayton Superior Corporation, Dur-O-Wal Division; DA 810, DA 812 or DA 817.

E. Outside joints at the perimeter of exterior doors shall not be less than 1/4" nor more than 3/8" wide and shall be cleaned out to a uniform depth of at least 3/4" for sealant, provided under Division 07 Section “Joint Sealers”.

2.08 MASONRY-CELL INSULATION

A. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

2.09 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use Portland cement-lime masonry cement or mortar cement mortar unless otherwise indicated.
   3. For exterior masonry, use Portland cement-lime masonry cement or mortar cement mortar.
   4. For reinforced masonry, use Portland cement-lime masonry cement or mortar cement mortar.
   5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type S.
   2. For reinforced masonry, use Type S.
   3. Color pigments shall not exceed 10 percent of Portland cement by weight.
   4. Color to be selected by Architect.

D. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, Table 1.
   3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

2.10 FORMWORK AND SCAFFOLDING

A. Design and engineering of formwork and scaffolding as well as its construction shall be the responsibility of the Contractor. Adequately shore all block soffits, beams, girders and similar members to safely support all loads and lateral pressures liable to come on the construction. Provide clean-out openings at each vertical bar at bottom course or in foundation wall when wall is erected in more than 5 foot lifts.

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect foundations to assure surfaces to support masonry are to proper grades and elevations, free of dirt or uneven surfaces. Defective surfaces shall be properly repaired prior to installation. Installation constitutes acceptance of substrate.

3.02 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 BUILT-IN WORK

A. Contractor shall carefully examine architectural and mechanical drawings providing all slots, chases, recesses in masonry work as required. No pipes shall be enclosed unless tested. Build-in all wood grounds, inserts, anchor bolts, iron frames, brackets or other items furnished by others and cooperate with other contractors in placing of such items. Consult other trades and make provisions for introduction of their work.

B. Where bolts are required for attaching steel plates, fill cores of units solid with grout. Set bolts and inserts vertically in top of walls, pilasters, beams or columns 3" minimum from any face in masonry 7 inches or more in thickness, and at center line of thinner masonry sections. Hold all metal accessories to masonry by firmly embedding anchorage into grout 3" minimum.

3.04 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.05 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet maximum.
   3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet maximum.
   5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet maximum.

C. Concrete masonry units shall be set plumb and true in lines with regular bond and properly jointed to other work with fully bedded joints and cross joints. Vertical joints on exposed masonry units shall be concave tooled, mortar joints 3/8" thick unless otherwise noted. Units set in running bond pattern, vertical joints staggered on center of block below. Where indicated, align vertical cells to be filled with grout to provide a continuous unobstructed opening of dimensions. Provide mortar pointing of all scored concrete masonry to match adjacent joints.

D. Joints:
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
   2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
   3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
   4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

E. When a block must be reduced in size or is shown on the drawings to be of a smaller size, use an approved masonry saw to cut the block and properly dress the roughened edges. Chipped, cracked, broken or otherwise defective blocks will not be acceptable.

F. All interior non-bearing partitions shall be carried to within 1/4 inch of the deck leaving a gap to be caulked, unless shown otherwise on drawings.

G. Use standard plain grey mortar at standard gray blocks.

3.06 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
   3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
   4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."

3.07 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
   1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
   2. Allow cleaned surfaces to dry before setting.
   3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.08 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to one story high, but not more than 20 feet.

B. All holes and openings in the wall through which insulation can escape shall be permanently sealed.

C. Insulation shall be poured directly into the block cells at maximum 3'-4" intervals. Wall sections below openings shall be filled before sills are placed.

3.09 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

F. Furnish and install steel reinforcement, maintaining minimum required clear distances.

G. Where detailed, install grout fully around steel reinforcement. Grouting done in lifts of 24" (for spaces less than 2" wide) and 48" (more than 2" wide). Agitate and puddle grout during and after placement. Exercise care to prevent grout from staining face of masonry. Immediately remove grout spillage on face and top of masonry.

H. Minimum compressive prism strength of the masonry (f'm) shall be 2500 psi when tested at 28 days.

I. All CMU walls shall be reinforced horizontally with reinforcing spaced 16" o.c. vertically, maximum. Lay reinforcing on wall and cover with mortar, then bed unit as herein specified. At corners, reinforcing is to be provided in every horizontal

course, with inside rod cut and bent to form corner. Provide reinforcing one course above and below all openings. Reinforcement placed as to assure a 5/8" mortar cover measured from the outside face of the joint. Side rods shall be lapped at least 14" at splices.

J. Intersecting and butting walls and partitions shall be bonded together by metal anchors spaced 2' - 0" o.c. vertically. Interlocking of units not permitted.

3.10 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
   1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 36 inches o.c. horizontally.

3.11 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using the following method:
   1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

3.12 LINTELS

A. Provide galvanized steel lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.13 FLASHING

A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
5. During the installation extend end of flexible flashing past face of the exterior wall so that Architect may verify installation.
6. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install cell vent weeps in vertical joint of first course immediately above all flashings, weep spaces 24" O.C.

3.14 REINFORCED UNIT MASONRY INSTALLATION

A. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

C. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

D. Owner will employ and pay for the services of an independent testing laboratory to perform the inspection and testing services specified in this section.

E. Provide a qualified inspector to inspect all structural masonry work on a periodic basis. Inspect the work in progress at least once for every 5000 square feet of wall laid, but not less than once per day.

F. Inspect the following:
   1. Preparation of masonry prisms for testing.
   2. Placement of reinforcing.
   3. Cavities to be grouted.
   4. Mortar mixing operation.
   5. Grouting operation.
   6. Condition of units before laying for excessive absorption.

G. Compressive Test for Mortar:
   1. Secure composite samples of mortar at the job site in accordance with ASTM C780.
   2. Mold and cure three cube specimens in accordance with ASTM C109 and C780. Supervise the curing protection provided by the contractor for test specimens in the field and the transportation from the field to the laboratory. The specimens shall be stored in the field 24 hours and then be moved to the laboratory and cured in accordance with ASTM C780.
   3. Test specimens in accordance with ASTM C780. Two specimens shall be tested at 28 days for acceptance and one shall be tested at seven days for information.
   4. Make one strength test (three cubes) for each 5000 square feet of wall area.

H. Test for Grout:
   1. Secure composite samples of grout at the job site in accordance with ASTM C172.
   2. Mold and cure three, 3” diameter by 6” tall cylinders form each sample in accordance with ASTM C31. Supervise the curing protection provided by the contractor for the test specimens in the field and transportation to the laboratory. The test cylinders shall be stored in the field 24 hours and then moved to the laboratory and cured in accordance with ASTM C31.

3. Test specimens in accordance with ASTM C39. Two test specimens shall be tested at 28 days for acceptance and one shall be tested at seven days for information.
4. Make one strength test (three cylinders) for each five cubic yards of grout placed, but not less than one strength test for each 5000 square feet of wall area.

I. Prism Tests:
1. Build prisms at the job site using the same materials and methods as being used for the wall construction. Store prisms in a place where they will be undisturbed for two days and have approximately the same curing conditions as the masonry construction. After 48 hours, move prisms to the laboratory and test in accordance with ASTM E447.
2. Concrete Masonry Units: Build prisms of hollow masonry units the same width as the unit by 16" long by 16" high. Apply mortar to the face shells only. Do not fill hollow core with grout. Compute value of ultimate net compressive strength, by dividing the ultimate load by the net face shell area of the masonry units.
3. Bricks: Build brick prisms one brick width and length in plan and five bricks high, using full bed joints as specified. Compute ultimate compressive strength by dividing ultimate load by gross area of bricks.
4. The prisms shall be tested after 28 days, but may be tested at seven days provided the relationship between seven and 28 day strengths has been established for the materials used prior to the start of construction.

3.16 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00

SECTION 04 43 00 - STONE MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide stone exterior wall material, laid up like masonry, as shown on the Drawings and as specified herein.

B. Related Sections include the following:
   1. Division 05 Section - Steel Lintels, loose.
   2. Division 07 Section - Flashing, Sheet Metal.
   3. Division 07 Section - Sealants.

1.03 SUBMITTALS

A. Submit shop drawings per requirements of Division 01 Section, showing layout and details of construction, anchors, jointing and setting.

B. Submit one 12" x 12" samples of each type of finish of stone specified, showing full range of colors, for approval by Architect.

C. Copies of complete data on stone fabricator. Architect reserves the right to reject the fabricator if adequate past experience in the production of the types of units specified is not assured by the data submitted.

D. Copies of supplier's specifications and test data for type of stone required, including certification that stone complies with the specified requirements. Include instructions for handling, storage, installation and protection of stone.

E. Copies of complete data showing all colors, textures and finishes available.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store materials in a dry place, above ground on level platforms. Cover and protect units as necessary from elements.

1.05 JOB CONDITIONS

A. Coordinate stonework with other trades whose work relates to this section, in any manner, for placing of all required backing, blocking and leave-outs, etc.

B. Masonry work shall not be placed when there is any possibility of the water freezing before it has attained its initial set. In weather below freezing, all masonry units and mortar shall be heated. Walls which have frozen after making their initial set shall not be built upon until they have had sufficient time to make a proper set at temperatures above freezing.

C. All newly placed masonry shall be protected against damage from action of the elements and under no condition shall rain be allowed to fall on, drive against or flow down masonry surfaces until mortar has set a minimum of 12 hours. Tops of all walls shall be covered with a waterproof material at the end of each day.

D. All newly placed stone shall be protected from damage of any sort.

1.06 QUALITY ASSURANCE

A. Qualification of fabricator: Obtain each stone from single quarry source, with accepted color range and texture throughout the work as established by approved samples.

B. Sources or kinds of materials as approved shall not be changed during course of work.

C. Stone fabricator shall have successfully fabricated work similar to quality specified in quantity shown for period of not less than 5 years.

D. Stone fabricator shall have been engaged in the business of fabricating stone specified for a period of not less than (5) years. Provide reference including project name, project architect and General Contractor.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
   1. ASTM C 97, Absorption and Bulk Specific Gravity of Natural Building Stone
   2. ASTM C 99, Modulus of Rupture of Natural Building Stone
   3. ASTM C 170, Compressive Strength of Natural Building Stone.
   4. Masonry Institute of America Handbook for Marble & Stone Slab Veneer.

F. Mockups: Build Mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockups for typical exterior walls in sizes as indicated in drawings
   2. Build mockups according to mock-up drawings and details with all required materials
   3. Arrange Building Stone and Cut Accent Stone as indicated in mock-up drawings and details.
   4. Approval of mockups in relation to stone is for color, texture, setting and anchoring, flashing, mortar color and tooling, and sealant colors in expansion joints, and overall aesthetic and quality of workmanship
      a. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless specifically approved in writing from the Architect.

1.07 DELIVERY, STORAGE & HANDLING

A. Delivery of Materials:
   1. Carefully pack and unload stone with necessary caution to avoid damaging or soiling stone.
   2. Deliver stone in original package or pallets, plainly marked with identification of materials and manufacturer.

B. Storage of Materials:
   1. Store stone clear of the ground on non-staining skids made of non-chemically treated wood or of wood not containing tannin.
   2. Cover stone on all sides and bottom with waterproof paper, clean canvas or polyethylene.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All stone shall be standard grade, free from cracks, seams or other imperfections which might impair its structural integrity and finish. All stone furnished must conform to and be within the range of approved samples. Cut accurately to shape and dimensions shown on

final shop drawings. Variations on surfaces from true plane shall not exceed 1/8" for smooth finish.

B. Stone:
   1. Color, texture and finish within range of samples approved by Architect.
   2. Building Limestone:
      a. Source: “Fire House Blend” by Ledbetter Brick & Stone Co.,
         Brenham, Texas
         (979) 836-3178
      b. Finish: Natural
   3. Pattern: Random Ashlar
   4. Complying with ASTM C 568, Category II (medium density)
   5. Minimum compression strength 4000 psi per ASTM C170 and maximum absorption 7.5% per ASTM C 97
   6. Sizes:
      a. 6”, 8”, 10”, and 12” tall modular units, 3” – 5” depth
      b. Corner pieces
      c. Mitered corners (field sawn)
      d. Custom sizes (field sawn)
   7. Cut Accent Stone:
      a. Source: “Cave Select” by Ledbetter Brick & Stone Co., Match accepted samples approved by Architect.
      b. Stone #1 2” Cut Stone
      c. Location Tops of Concrete Bollards
      d. Stone #2 4” Cut Stone
      e. Location 4” tall Banding between Building Limestone
      f. Stone #3 4” Cut Stone
      g. Location Sill/Transition from Building Limestone to Fiber Cement Siding
      h. Stone #4 6” Cut Stone
      i. Location Window Sills through Building Limestone
      j. Stone #5 6” Cut Stone
      k. Location Window Heads through Building Limestone
      l. Corner pieces
      m. Mitered corners (field sawn)
      n. Custom size (field sawn)

2.02 VENEER ANCHORS

A. Materials:
   1. Hot-Dip Galvanized-Steel Wire Conforming to ASTM A1064/A1064M, ASTM A82/ A82M, Class B-2

B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8” cover on outside face.

C. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch-diameter, hot-dip galvanized-steel wire.
   1. Ties are bent in the form of triangular loops designed to be attached to masonry joint reinforcement specified in Division 04 Section "Unit Masonry" with vertical wires passing through ties and through eyes projecting from masonry joint reinforcement.

D. Masonry Wall Tab Anchors at concrete block: A 4" rectangular hot-dip galvanized adjustable ladder tab for cavity installation equal to Wire Bond Series 600.

E. Adjustable, Screw-Attached Veneer Anchors: Units consisting of a wire tie section and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

1. Products: Subject to compliance with requirements provide:

a. Dur-O-Wal, a Dayton Superior Company; D/A 213 or D/A 210 with D/A 700-708.

b. Heckmann Building Products Inc.; 315-D with 316 or Pos-I-Tie.

c. Hohmann & Barnard, Inc.; DW-10, DW-10HS or DW-10-X.

d. Wire-Bond; 1004, Type III or RJ-711.

2. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or develop-ing play in excess of 0.05 inch.

3. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches wide by 3 inches high; with projecting tabs having slot-ted holes for inserting vertical legs of wire tie specially formed to fit veneer anchor section.

4. Anchor Section: Sheet metal plate, 1-1/4 inches wide by 9 inches long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch wide by 3-5/8 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie.

5. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch-diameter, hot-dip galvanized-steel wire.

2.03 STONE TRIM ANCHORS

A. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Halfen Anchoring Systems; Meadow Burke.

b. Heckmann Building Products Inc.

c. Hohmann & Barnard, Inc.

B. Materials: Fabricate anchors from stainless steel, ASTM A 240/A 240M, Type 304. Fabricate dowels from stainless steel, ASTM A 276, Type 304.

2.04 ACCESSORIES

A. Spacers: Impact resistant plastic (1/4” max. thickness)

B. Membrane Flashings: 32 mil thick rubberized asphalt laminated to 8 mil polyethylene film, release paper facing, self adhering

C. Joint Sealers: Specified in Division 07 Section.

D. Cleaning Solution: type that will not harm stone, joint material, or adjacent surfaces.

2.05 FABRICATION

A. Cut adjacent pieces from same block wherever possible.

B. Provide kerf slot in top and bottom of panels.

C. Form stone corners to miter kerf joint profile.

D. Anchorage:
   1. Space anchors at maximum 16 inches on center and around perimeter.

E. Fabrication Tolerances
   1. Variation in width or height: plus or minus 1/8 inch
   2. Variation in thickness: plus or minus 1/8 inch
   3. Variation in form true plane: plus or minus 1/16 inch in 3 feet

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect foundations to assure surfaces to support masonry are to proper grades and elevations, free of dirt or uneven surfaces. Examine all subsurfaces to receive stone work. Report in writing to General Contractor, with a copy to Architect, any conditions which may prove detrimental to the work. Commencement of work will be construed as acceptance of all subsurfaces.

3.02 PREPARATION

A. Establish lines, levels and coursing. Protect from disturbance.

B. Clean stone prior to installation. Do not use wire brushes or implements that can mark or damage exposed surfaces.

C. Wet absorptive stone in preparation for placement to minimize moisture suction from mortar.

3.03 STONE INSTALLATION

A. Install in accordance with stone manufacturer

B. Arrange stone pattern to provide color uniformity and constant joint sizes throughout.

C. Set stone plumb and level. Align adjacent pieces in same plane.

D. All anchors shall be concealed.

E. Coordinate with other trades for placement of inserts and anchors. Provide templates or drawings as required.

F. Execute work with skilled mechanics and employ skilled fitters at site to do necessary field cutting as stone is set.

G. Provide openings and other spaces as shown or required for contiguous work. Close up openings in stone after other work is in place. Use materials and set to match surrounding work.

H. Set stone in accordance with final shop drawings.

I. Have all work done by competent stone masons and to appearance approved by Architect.

J. Remove and replace damaged or defective stonework to match adjacent acceptable stonework.

3.04 FLASHINGS AND WEEP HOLES

A. All flashings installed in accordance with herein specified requirements and in accordance with manufacturer's recommendations so that all flashing work properly drains water to the outside.

B. Provide smooth mortar beds, slightly pitched to the outside face of the wall at all points where flashings are to be installed over horizontal surfaces.

C. Flashing shall extend beyond outside face of wall as detailed on drawings.

D. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends, turn up and fold not less than 2 inches to create a folded end dam, per manufacturers recommendations & literature

E. Install weep vents in vertical joint of first course above flashings at 24" o.c.

F. Flashing to be installed with top edge extending behind sheathing as detailed on drawings.

3.05 CONTROL & SOFT JOINTS

A. Make adequate provisions throughout the stone work for expansion and contraction. Install preformed control joint gasket, extending from top of bearing surface to top of wall, reinforcing shall not run through.

B. Install soft joint material at top of stone.

3.06 SEALED JOINTS

A. Outside joints at the perimeter of exterior door and window frames shall not be less than 1/4" nor more than 3/8" wide and shall be cleaned out to a uniform depth of at least 3/4" for sealant, provided under Division 07 Section.

3.07 BUILT-IN WORK

A. Contractor shall carefully examine architectural and mechanical drawings providing all slots, chases, recesses in masonry work as required. No pipes shall be enclosed unless tested.

3.08 INSTALLATION TOLERANCES

A. Maximum variation from level and plumb: 1/8 inch in 10 feet, noncumulative.

B. Maximum variation in plane between adjacent pieces as joint: Plus or minus 1/16 inch.

3.09 CLEANING

A. Clean stone with stiff brushes and water.

B. If initial cleaning does not produce acceptable results, apply cleaner in accordance with manufacturer’s instructions
   1. Prior to applying, clean sample panel in area as directed by Architect. If approved, use same materials and techniques for cleaning remainder of stone.
   2. Protect adjacent surfaces.
   3. Wet stone prior to applying cleaner.
   4. Thoroughly rinse surfaces with water after completion of cleaning: remove all traces of cleaning solution.

3.10 PROTECTION

A. Protect stonework from soiling and damage during all phases of construction.

END OF SECTION 04 43 00

SECTION 04 72 00 - CAST STONE MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. This specification covers all labor, materials and services incidental to and including the furnishing and setting of all Cast Stone as indicated on the drawings and specified herein.
   2. The Manufacturer shall be responsible for all labor, materials, equipment and services necessary for an incidental to providing all Cast Stone covered by this Specification.
   3. The Setting Contractor shall unload, receipt for, protect, store and set all Cast Stone covered by this Specification and shall provide and install all anchors for same.

B. Related Sections:
   1. Division 04 Section - Unit Masonry Assemblies, for miscellaneous masonry accessories.
   2. Division 05 Section - Cold-Formed Metal Framing, for steel stud frames supporting dimension stone cladding.
   3. Division 07 Section - Fluid Applied Membrane Air Barriers, for membranes applied to exterior face of exterior sheathing at exterior masonry cavity walls.
   4. Division 07 Section - Sheet Metal Flashing and Trim, for exposed sheet metal flashing.
   5. Division 07 Section - Firestopping, for firestopping at openings in masonry walls.
   6. Division 07 Section - Joint Sealants, for sealing control and expansion joints in unit masonry.
   7. Division 07 Section - Thermal Insulation, for cavity wall insulation.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:
   1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

C. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
   1. Include building elevations showing layout of units and locations of joints and anchors.
   2. Show locations and details of flashing at a scale no less than 3 inches per 12 inches.

D. Samples for Initial Selection: For colored mortar.

E. Samples for Verification:
   1. For each color and texture of cast stone required, 10 inches square in size.
   2. For colored mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicated types and amounts of pigments used.

F. Full-Size Samples: For each color, texture, and shape of cast stone unit required.

1. Make available for Architect's review at Project site.

1.04 QUALITY ASSURANCE

A. The Manufacturer shall have been a recognized and reputable Cast Stone manufacturer for a minimum of five years continuous operation, and shall have adequate experience, facilities and capacity to furnish the quality, sizes and quantity of Cast Stone required without delaying the progress of the work. The Manufacturer's products shall have been previously used and exposed to the weather with satisfactory results.

B. Standards: Comply with the requirements of the Cast Stone Institute[SM] Technical Manual and the project specifications. Where a conflict may occur, the contract documents shall prevail.

C. All Cast Stone used in this work shall be manufactured by cast stone manufacturer and shall have minimum compressive strength of 6500 lbs. per square inch and absorption of no greater than 6% when tested in accordance with the requirements of this Specification.

D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

E. Source Limitations for Cast Stone: Obtain cast stone units through single source from single manufacturer.

F. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

B. Pack, handle, and ship cast stone units in suitable packs or pallets.
   1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
   2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.06 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.01 CAST STONE MATERIALS

A. General: Comply with ASTM C 1364 and the following:

B. Portland Cement: ASTM C 150, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114. Provide natural color or white cement as required to produce cast stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation and colors as needed to produce required cast stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation and colors as needed to produce required cast stone textures and colors.

E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

F. Admixtures: Use only admixtures specified or approved in writing by Architect.
   1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
   2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
   3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.

G. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast stone material.
   1. Epoxy Coating: ASTM A 775/A 775M.
   2. Galvanized Coating: ASTM A 767/A 767M.

H. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666, Type 304.

2.02 CAST STONE UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by the one of the following:
   1. Advanced Cast Stone Inc., 115 Lee Street, Everman, Texas 76140, (817) 572-0018 Fax (817) 293-6378, Email: tim@advancedcaststone.com, URL: www.advancedcaststone.com.
   2. AHI Supply, LP, 2800 North Gordon, Alvin, Texas 77511, (281) 331-0088 Fax (281) 331-9813, Email: arhoden@ahi-supply.com, URL: www.ahi-supply.com.
   3. Continental Cast Stone of Texas Inc., 101 E Shady Grove Rd, Grand Prairie, Texas 75050, (972) 871-7866 Fax (972) 871-1251, Email: info@continentalcaststone.com.
   4. Stone Castle Industries Inc., 3615 Almeda Genoa, Houston, Texas 77047 (713) 440-6224 Fax (713) 440-6228, URL: www.stonecastleinc.com.

B. Regional Materials: Cast stone units shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Provide cast stone units complying with ASTM C 1364 using either the vibrant dry tamp method.

1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.

D. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
   1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
   2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
   3. Provide drips on projecting elements unless otherwise indicated.

E. Fabrication Tolerances:
   1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
   2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
   3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
   4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

F. Cure units as follows:
   1. Cure units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
   2. Keep units damp and continue curing to comply with one of the following:
      a. No fewer than five days at mean daily temperature of 70 deg F or above.
      b. No fewer than six days at mean daily temperature of 60 deg F or above.
      c. No fewer than seven days at mean daily temperature of 50 deg F or above.
      d. No fewer than eight days at mean daily temperature of 45 deg F or above.

G. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

H. Colors and Textures: As selected by Architect from manufacturer's full range

2.03 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Products: Subject to compliance with requirements, provide one of the following:
      1) Davis Colors; True Tone Mortar Colors.
      2) Lanxess Corporation; Bayferrox Iron Oxide Pigments.
      3) Solomon Colors, Inc.; SGS Mortar Colors.

D. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

2.04 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666.

B. Dowels: 1/2-inch- diameter, round bars, fabricated from Type 304 stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666.

C. Embedded Lettering for cast stone signage panels. Wording, size, and font type as indicated on drawings, to be approved by Architect prior to manufacturing. Paint embedded lettering with an exterior grade paint appropriate for cast stone surfaces, color to be selected by Architect.

2.05 MORTAR MIXES

A. Comply with requirements in Division 04 Section - Unit Masonry for mortar mixes.
   1. Use masonry cement mortar unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SETTING CAST STONE IN MORTAR

A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
   1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
   2. Coordinate installation of cast stone with installation of flashing specified in other Sections.

B. Wet joint surfaces thoroughly before applying mortar or setting in mortar.

C. Set units in full bed of mortar with full head joints unless otherwise indicated.
   1. Set units with joints 1/4 to 3/8 inch wide unless otherwise indicated.
   2. Build anchors and ties into mortar joints as units are set.
   3. Fill dowel holes and anchor slots with mortar.
   4. Fill collar joints solid as units are set.
   5. Build concealed flashing into mortar joints as units are set.
   6. Keep head joints in coping and other units with exposed horizontal surfaces open to receive sealant.
   7. Keep joints at shelf angles open to receive sealant.

D. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

E. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

F. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

G. Provide sealant joints at copings and other horizontal surfaces, at expansion, control, and pressure-relieving joints, and at locations indicated and as required to prevent stress cracking of large cast stone units.

1. Keep joints free of mortar and other rigid materials.
2. Build in compressible foam-plastic joint fillers where indicated.
3. Form joint of width indicated, but not less than 3/8 inch.
4. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section - Joint Sealants.

3.03 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
   1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
   2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.
   1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.
   1. Form open joint of width indicated, but not less than 3/8 inch.

F. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section - Joint Sealants.

3.04 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.05 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.
   1. Remove mortar fins and smears before tooling joints.
   2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
   3. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.

END OF SECTION 04 72 00

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Standard Form of Construction Agreement, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: This section covers furnishing all labor, materials, equipment, and services in connection with the furnishing, fabrication and erection of all structural steel work complete including:
   1. Steel Columns
   2. Steel Beams
   3. Shelf Angles
   4. Bolts
   5. Angle Frames Around Openings
   6. Laboratory Control
   7. Leveling Plates and anchor plates not cast in concrete or masonry.
   8. Shop Painting

B. Include all supplementary parts and members necessary to complete the structural steel frame, regardless of whether all such parts are definitely shown or specified, and furnish all such bolts, gussets, plates, etc. as may be required for proper assembly of all items.

C. Related Sections:
   1. Division 01 Section “Quality Requirements.”
   2. Division 05 Section “Metal Fabrications.”

1.03 DESIGN

A. Structural Performance: Engineer structural steel connections not specifically detailed by the Contract Documents to withstand design loadings indicated. Beam connections shall be standard AISC double angle unless shown otherwise.

B. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, supervise Shop Drawings, and select other structural data for structural steel connections.

1. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

C. Substitutions: Substitutions of sections or modifications of details, or both, and the reasons therefore, shall be submitted with the shop drawings for approval. Approved substitutions, modifications, and necessary changes in related portions of the work shall be coordinated by the fabricator and shall be accomplished at no additional cost to the Owner.

D. Responsibility for Errors: The fabricator shall be responsible for all errors of detailing, fabrications, and for the correct fitting of the structural members.

E. Templates: Templates shall be furnished by the fabricator with instructions for the setting of anchor bolts.

1.04 CODES

A. American Institute of Steel Construction:
   1. Specification for Structural Steel Buildings with commentary (AISC Manual of Steel Constuct 13th Edition).
   2. Code of Standard Practice for Steel Buildings and Bridges, 2005.

      However, the following sentence in paragraph 4.2.1 shall not apply: "This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as part of his preparation of these shop drawings.

   3. Specification for Structural Joints using ASTM A325X Bolts or A490X Bolts, November 13, 2004.

B. American Welding Society:
   1. Structural Welding Code-Steel. AWS D1.1.

C. Industrial Fasteners Institute:
   1. Handbook on Bolt, Nut and Rivet Standards.

D. Steel Structure Painting Council:
   1. Painting Manual, Volume 1, Good Painting Practice.
   2. Painting Manual, Volume 2, Systems and Specifications.

1.05 SUBMITTALS

A. Comply with pertinent provisions of Division 01 Section "Submittal Procedures", unless otherwise indicated.

B. Shop Drawings: Submit detailed shop and installation drawings, including design calculations for connections of the structural steel, to the Engineer for review. Steel for which such drawings have not yet been reviewed shall not be fabricated. Such review will cover the general conformance of design. The omissions from the shop and installation drawings of any materials shown on the Specifications shall not relieve the contractor of the responsibility of furnishing and installing such materials, even though such drawings may have been returned and reviewed.

C. Shop Drawings detailing fabrication of structural steel components:
   1. Include and indicate details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Indicate details of cuts, connections, splices, cambers, holes, and other pertinent data.
   3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
   4. Shop drawings shall be drawn at 1/8" = 1'-0" minimum for plans and ¾" = 1'-0" minimum for sections. Contract drawings shall not be reproduced in whole or in part. Contract drawings modified into shop drawings will be returned without review.
   5. Each sheet of the shop drawings shall bear the review stamp of the Contractor indicating the drawings have been reviewed and is approved. Shop drawings not bearing the Contractor's stamp will be returned without review.

D. Certified mill test reports, evidencing conformity with the requirements of the A.S.T.M. and A.I.S.C. Specifications, shall be submitted to the Architect, Structural Engineer, and Contractor for their respective records. Mill test reports will not be returned or approved.

E. Failure by the contractor to submit the shop drawings and test reports required above shall release the Architect and the Engineer from any liabilities due to the negligence on the part of the Contractor to comply with the construction documents.

PART 2 - PRODUCTS

2.01 MATERIAL GRADES

A. All structural steel except steel tubes: ASTM A572 Grade 50. Steel Tubes: ASTM A500, Grade B.

2.02 BOLTS

A. Bolts: Anchor bolts and erection bolts shall have minimum conformance to ASTM F1554 and to the requirements for regular hexagon bolts and nuts of ASA Standards B18.2.1 and B18.2.2.

B. High Strength Bolts and Nuts: ASTM A325X with the thread excluded from the shear plane. Bethlehem "Load Indicator Bolts" or LeJeune "Tension Control Fasteners" complete with mating nut and washer and J&M Turner load-indicator washers may be used.

C. Washers: Circular washers shall be flat and smooth, and shall conform to requirements of Type A washers in ASA Standard B27.2. Beveled washers for American standard beams and channels shall be square or rectangular, shall taper in thickness, and shall be smooth. Washers for use with high strength bolts shall be hardened.

D. Adhesive Anchors: Injectable adhesive for the installation of threaded anchors rods into concrete. Rods shall be ASTM A36. Adhesive shall be Hilti- HIT HY 150 or Simpson Acrylic-tie or approved equal.

2.03 WELDING ELECTRODES

A. Shall conform to the requirements of the Specifications of the American Institute of Steel Construction. Use E70 electrodes.

2.04 COATINGS

A. Paint: Shall conform to the requirements of Federal Specification TT-P-86 Type I of II, SSPC Paint 4-64T or Federal Specification TT-P-636C primer coating, synthetic, rust inhibiting primer. Tnemic series “1009” gray primer, or approved equal. Tnemec Paint Company, North Kansas City, Missouri.

B. Zinc-Coating: When galvanizing steel is required, the zinc-coating shall conform to ASTM A123 . Zinc-coating for threaded products shall conform to ASTM A153.

C. Cold galvanizing compound shall be “ZRC Cold Galvanizing Compound” as manufactured by ZRC Chemical Products, Quincy, Massachusetts.

PART 3 - EXECUTION

3.01 FABRICATION

A. General: Except as modified herein, fabrication shall be in accordance with the applicable Specifications and Standards of the American Institute of Steel Construction. Workmanship shall be equal to standard commercial practice in modern structural shops. Portions of the work exposed to view shall be finished neatly. Structural material, either plain or fabricated, shall be stored above the ground on platforms, skids, or other supports. Material shall be kept free from dirt, grease, and other foreign matter, and shall be protected as far as practical from corrosion. All material shall be clean and straight. If straightening or flattening is necessary, it shall be done by a process in a manner that will not damage the material. Finished members shall be free from undue twists, bends, warping distortion, and other irregularities. Holes shall not be made or enlarged by burning. Shearing, flame cutting, and chipping shall be done carefully and accurately. Splicing structural steel members shall not be permitted.

1. Compression joints, depending upon contact bearing, shall have the bearing surfaces machined to a common plane after the members are completed.
2. Protective Painting: One (1) coat of approved primer shall be applied to all exposed surfaces of all structural steel members except those surfaces requiring field welding, to be encased in concrete, to be galvanized, to be spray fireproofed and the top flanges of beams to support metal deck.

   All metal surfaces to be painted shall be cleaned of all loose mill scale, dirt, rust, etc. by the use of steel scrapers, wire brushes, sandblast or other means approved by the Architect. Oil and grease shall be removed with naphtha and the metal surfaces shall be dry when paint is applied.

   Paint shall not be applied during damp weather, or when the temperature is at or below freezing. Any damage to the shop coat of paint and welded areas where shop paint was omitted shall be field painted with shop paint to the satisfaction of the Architect.

   Steel work specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt, and other foreign material by thorough sweeping with a fiber brush. Apply shop paint to provide a minimum dry film thickness of 2.0 mils.

3. Bolted Construction: Holes for bolted construction shall be fabricated as specified for bolted construction. Bolt holes shall be at right angles to the member. The slope of bolted parts in contact with the bolt head shall not exceed 1:20 with respect to a plane normal to the bolt axis. Where the surface of a bolted part has a slope of more than 1:20, a beveled washer shall be used to compensate for the lack of parallelism. Bolt holes shall have a nominal diameter not greater than one-sixteenth (1/16) inch in excess of the nominal, bolt diameter.
4. Common Bolts: The bolts shall be of such length that they will extend entirely through the nuts, with the beveled end outside the nut. Bolt heads and

nuts shall be drawn tight against the work with a suitable wrench not less than fifteen (15) inches long. Threads shall be excluded from shear plane

5. Baseplates: Oversize anchor bolt holes in baseplates to facilitate erection as follows:

   Bolts 3/4" to 1" in diameter: 5/16" oversize
   Bolts 1" to 2" in diameter: 1/2" oversize

   Use oversize nut or plate washers under nut at all oversized holes in baseplates. Washers must be large enough to cover hole. Washer thickness shall be at least 1/8 of bolt diameter.

6. Camber: Provide camber in members indicated on the drawings. Specified camber applies at the jobsite, just prior to erection, lying flat so that the member weight has no effect. Take necessary precautions to prevent or compensate for camber loss during shipment. Measured camber in members up to 50'-0" long shall be within a tolerance of minus 1/2" to plus zero from the specified camber. Members with field measure camber outside the specified camber shall be returned to the shop.
7. Galvanizing: the following members shall be hot dip galvanized: masonry shelf angles, and any steel members exposed to weather, and where noted on drawings.

3.02 ERECTION

A. General: Except as modified herein, erection shall be in accordance with the applicable Specifications and Standards of the A.I.S.C. Manual of Steel Construction. Where parts cannot be assembled or fitted properly as a result of errors in fabrication or of deformation due to handling or transportation, such condition shall be reported immediately to the testing laboratory for approval of the method of correction obtained. The straightening of plates and angles or other shapes shall be done by approved methods. Bent or damaged heat-treated parts will be rejected. Steel work shall be drained properly; pockets in structures exposed to the weather shall be filled with an approved waterproof material. The erector will be responsible for shrinkage and distortion of all butt welds. Loose joints will be corrected by cutting with a hand guided torch if necessary.

B. Assembly:
   1. Temporary bracing shall be used wherever necessary to support all loads to which the structure may be subjected, including equipment and operation thereof and piles of materials. Such bracing shall be left in place as long as required for safety. The various members forming parts of a completed frame or structure after being assembled shall be aligned and adjusted accurately before being fastened. Splicing of compression members shall be done after the abutting surfaces have been brought into contact.

2. Bearing surfaces and surfaces which will be in permanent contact shall be cleaned before the members are assembled. Bearing plates shall be set in exact position and shall have a full and even bearing upon the concrete. As erection progresses, the work shall be bolted or welded sufficiently to take care of all dead load, wind, and erection stresses. Splices will be permitted only where indicated. All erection bolts used in welded construction may be tightened securely and left in place; if removed, the holes shall be filled with plug welds.

C. Field bolting shall be in accordance with the requirements specified for shop fabrication. Unfair holes shall be corrected by reaming. Where the surface of a bolted part has a slope of more than 1:20, a beveled washer shall be used to compensate for the lack of parallelism. Bolt heads and nuts shall be drawn tight against the work with a suitable wrench not less than fifteen (15) inches long. Bolt heads shall be tapped with a hammer while the nut is being tightened.

D. Bolts to be "snug-tight" unless noted otherwise, and shall be tightened a few impacts of an impact wrench or the full effort of a man using a ordinary spud wrench, bringing the plies into contact. Field welding shall be as specified for shop fabrication of welded construction. Any shop paint on surfaces adjacent to joints to be field welded shall be wire brushed to reduce the paint film to a minimum. Slag shall be removed from all completed welds.

E. Field repair of zinc-coatings with cold galvanizing compound per manufacturer's specifications.

F. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

G. Setting baseplates: Set baseplates on shims or other adjustment devices. Tighten anchor bolts after supported members have been positioned and plumbed. Cut off protruding wedges or shims. Grout under baseplates in accordance with Division 3: Section Cast-in-Place Concrete.

3.03 FIELD QUALITY CONTROL

A. An independent testing laboratory shall perform inspection and testing services specified in this section.

B. Shop Inspection
   1. Visual inspection of all shop welding.
   2. Ultrasonic inspection of all full penetration welds.
   3. Examination of galvanizing.
   4. Examination of shop painting.

C. Field Inspection
   1. Proper erection of all pieces.
   2. Proper installation of all bolts, including checking the calibration of impact wrenches used with high strength bolts.
   3. Plumbness of structure and proper bracing.
   4. Ultrasonic inspection of all full penetration welds.
   5. Record and measure camber of beams upon arrival and before erection for compliance with the specified camber. Measure beam lying flat with web in the horizontal position. Members outside the specified camber tolerance shall be returned to the shop and replaced with members meeting the specified camber tolerance.

D. Qualification of Welders: Before assigning any welder to work covered by this section of the Specifications, the fabricator shall provide the Testing Laboratory with certification that each of the welders to be employed on the project has passed qualification tests within the last year using procedures covered in the American Welding Society Standard D1.0-63.

E. The contractor shall be responsible for furnishing fabrication and erection inspection and testing of all welds in accordance with AWS D1.1, Chapter 6. Submit records of inspections and tests to the testing laboratory for their review.

F. Inspection of shop and field welding shall be "verification inspection" in accordance with Section 6 of AWS D1.1 and as follows:
   1. Visually inspect the welding of all shop fabricated members and note the location of all cover plates, connectors, bearing stiffeners, splices, and fillet welds for proper return around ends and check for seams, folds, and delaminations.
   2. Ultrasonically test all full penetration welds in accordance with ASTM E164.
   3. Root passes shall be thouroughly inspected for cracks. All cracks shall be gouged out and rewelded to two inches beyond each end of the crack.
   4. Mark all welds requiring repairs and make reinspections.
   5. The Testing Laboratory inspector shall advise the Owner and Architect of any shop and/or field conditions which, in his opinion, may require further tests and examination. Such further tests shall be performed as authorized by the Owner and Architect.
   6. The Owner reserves the right to use ultrasonic or radiographic inspection to verify the adequacy of all welds. Testing procedures and acceptance criteria shall be as specified in AWS D1.1.

G. Inspection of bolted construction shall be in accordance with AISC "Specification for Structural Steel Buildings" and as follows:
   1. All bolts shall be visually inspected to ensure that the plies have been brought into "snug" contact.

2. High strength bolts shall be inspected in accordance with Section 9 of the AISC "Specifications for Structural Joints Using ASTM A325X or A490X Thread Excluded Bolts."
3. For all high strength bolts, unless specifically noted on the Drawings to require only "snug-tight" installation, the inspector shall observe the required jobsite testing and calibration, and shall confirm that the procedure to be used provides the required tension.

END OF SECTION 05 12 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. General: Furnish all labor, supervision, materials, tools, equipment, appliances and services necessary for the fabrication, delivery and installation of all miscellaneous metal items. All work shall be as shown or indicated on the drawings and as specified in this section.

B. Scope of Work:
   1. Embedded angles and plates
   2. Guardrails, Handrails, and Handrail Brackets
   3. Ladders Expansion Joint Covers
   4. Steel Countertop Supports
   5. Steel Equipment Supports
   6. Metal Gratings
   7. Steel Plate Covers for Sidewalk Culverts
   8. Pipe Guards
   9. Downspout Protection
   10. Pipe Bollards
   11. Cast Iron Wheel Guards
   12. Vehicular Sign Posts
   13. Miscellaneous metal work and related items.
   14. Shop Priming and Finishing of Metal Fabrications

C. Related Sections include the following:
   1. Division 03 Section - Concrete.
   2. Division 04 Section - Unit Masonry.
   3. Division 05 Section - Metal Pan Stairs.
   4. Division 05 Section - Aluminum Ships Ladder.
   5. Division 06 Section - Rough Carpentry, for concealed blocking for attachment of metal fabrications.
   6. Division 07 Section - Roof Accessories, for roof hatches and ladder safety devices attached to fabricated ladders.
   7. Division 08 Section - Access Doors and Panels, for metal floor hatches.
   8. Division 09 Section - Painting.
   9. Division 09 Section - Special Coatings.
   10. Division 11 and other Sections for equipment requiring miscellaneous steel support structure.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design miscellaneous supports and railings, including engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design Criteria:
   1. Ladders designed to withstand live loading conditions of 100 lb. per square feet.

2. Handrails, Guardrails, or other protective enclosures shall be designed to withstand stresses to which they would be normally subjected, and to support a load of 50 lb per linear foot applied perpendicular at the top of the rail or guard, and to withstand a load of 200 lbs. applied in any direction at any point on the top of the rail or guard without deflection.
3. Connections other than those already listed shall be designed to safely support design load (dead load plus live load) of not less than 100 psi without exceeding working stresses permitted for materials.
4. Design ladders to include platforms and safety cages where shown in Drawings and where required by local code and authorities having jurisdiction.
5. Miscellaneous countertop supports designed to safely support a load of 200 lb per linear foot of countertop applied at the outside edge, as well as any additional requirements as specified in Division 06 Section - Architectural Woodwork.
6. Miscellaneous equipment supports per local code requirements, equipment Manufacturers' requirements and as specified herein.

1.04 QUALITY ASSURANCE

A. Steel stairs in accordance with latest NAAMM Standards and AISC.

B. Welding shall conform to American Welding Society's Standard Code for Arc and Gas Welding in Building Construction. Welding shall be continuous along entire area of contact, except where tack welding is specifically shown or specified. Grind all exposed welds.

1.05 SUBMITTALS

A. Shop drawings based on the Contract Documents shall be submitted to the Architect for review prior to ordering of materials.

B. Failure by the contractor to submit shop drawings, test reports, etc. required above shall release the Architect and the Engineer from any liabilities due to the negligence on the part of the contractor to comply with the construction documents.

C. Approval will cover size and arrangement of members, character of construction, but not dimensions.

D. Contractor shall verify actual dimensions at the construction site.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Comply with the following standards, as pertinent:
1. Steel plates, shapes, and bars: ASTM A36;
2. Steel plates to be bent or cold-formed: ASTM A283; grade C;
3. Steel tubing (hot-formed, welded, or seamless): ASTM A500; grade B;
4. Steel bars and bar-size shapes: ASTM A306; grade 65, or ASTM A36;
5. Cold-finished steel bars: ASTM A108l
6. Cold-rolled carbon steel sheets: ASTM A336;
7. Galvanized carbon steel sheets: ASTM A526, with G90 zinc coating in accordance with ASTM A525;
8. Stainless steel sheets: AISI type 302 or 304, 24 ga. with number 4 finish;
9. Gray iron castings: ASTM A48, class 10;
10. Malleable iron castings: ASTM A47;
11. Steel pipe: ASTM A53, grade A, schedule 40, black finish unless otherwise noted;
12. Concrete inserts:

a. Threaded or wedge-type galvanized ferrous castings of malleable iron complying with ASTM A27.
b. Provide required bolts, shims, and washers, hot-dip galvanized in accordance with ASTM A153.

13. Bolts and nuts: Provide hexagon-head regular type complying with ASTM A307, grade A.
14. Lag bolts: Provide square-head type complying with Fed Spec FF-B-561;
15. Machine screws: Provide cadmium plated steel type complying with Fed Spec FF-S-111.

B. Castings shall be made from the best grade of soft pig iron cast in stove place molding sand to a uniform thickness. Castings shall be free of defects impairing strength or appearance.

C. Accessories: Provide all anchors bolts, anchor straps, hangers and other related fittings, fastener and accessories required for proper and secure installation of all miscellaneous metal. Fasteners for exterior use shall be zinc coated. Generally, the sizes, shapes and spacing of items are shown or specified; where not shown or specified, accessories shall be adequate for the required services, subject to approval.

2.02 ITEMS TO BE PROVIDED

A. Lintel Angles and Bent Plates: Hot-Dipped Galvanized steel in sizes indicated on Drawings. Extend loose lintel angles 8" on each side of opening.

B. Steel Pipe Guardrails: 1-1/4" Standard galvanized steel pipe as detailed in Drawings. Hot-dipped galvanized steel at all exterior railings.

C. Steel Pipe Hand Railings: 1-1/4" Standard steel pipe fabricated with welded and round smooth connections as illustrated on Drawings or as required. Hot-dipped, galvanized steel pipe at all exterior handrailings, galvanize railings after fabrication. All railings to have closed ends.

1. Where railings do not return to post or to a vertical or horizontal surface, provide domed ends.
2. Except where specifically detailed otherwise, railings in new concrete shall be mounted to cast-in galvanized steel sleeves.
3. Heavy Duty Handrail Brackets: Model RB14030 wall mount bracket as manufactured by The Wagner Companies. Galvanized at exterior application, painted to match railing at interior applications.
4. Handrail Brackets: 1-1/2” wide x 1/4” thick steel bent plate handrail brackets] [steel handrail brackets as detailed in Drawings, galvanized at exterior application, painted to match railing at interior applications.
5. Provide any other attachments to new and existing construction as required to comply with design loading criteria.

D. Lobby Handrail: 1 1/2” diameter clear anodized aluminum railing with 5 1/4” radiused corners shall be “Wesrail” by Moultrie Manufacturing Company (800 / 841-8674).

E. Steel Pan Stair: Welded steel pan construction with steel channel stringers, pipe columns, Stair Nosings: 4” deep x 5/16” thick, cast metal safety tread nosings with cast-in aluminum oxide grit surface and concealed integral anchors on 10” centers for casting into concrete. Provide with protective tape to be removed at substantial completion.

1. Interior Metal Pan Stairs: Full width of stairs, equal to Ferragrit 101SP, plain surface, as manufactured by Wooster Products, or approved equal.
2. Exterior Cast Concrete Stairs: Full width minus 3” on each side of stairs, anti-corrosive metal equal to Alumagrit 101, cross-hatched surface, as manufactured by Wooster Products, or approved equal.

F. Metal Ships Ladder: Provide metal ship's ladder where indicated. Fabricate of open-type construction with channel or plate stringers, pipe and tube railings, and bar grate treads, unless otherwise indicated. Provide brackets and fittings for installation. Fabricate ships' ladders, including treads and railings from steel. Galvanize ships' ladders, including treads, railings, brackets, and fasteners. Construct as follows:
   1. Angle: 50 to 60-degrees from horizontal. Angle must not exceed 60-degrees.
   2. Stringer: C12 x 20.7 steel stringer.
   3. Treads: Serrated Bar Grate with diamond-pattern front lip.
   4. Tread Attachment: Weld treads to stringers, and secure with (2) 1/4" round-head bolts each side.
   5. Slab Attachment: Attach base plates to slab with 3/8" x 5" expansion anchors. Provide non-shrink grout between slab and base plate.
   6. Ladder Handrail: 1-1/4" standard steel pipe, welded to stringer at 4'-0" O.C.

G. Steel Ladder: Fabricate roof access ladders to configurations as indicated on drawings and as follows:
   1. 3-3/8" x 1/2" plate stringers with 3/4" diameter solid steel rod rungs shouldered and welded to stringers.
   2. Rungs spaced not over 12" apart. Distance from centerline of rungs to walls or obstructions not less than 6".
   3. Stringers secured to wall by 1/4" x 3" x 7" bent steel plate brackets bolted to wall with 3/8" diameter toggle bolts. Brackets secured to wall at 24" O.C. turned inward.
   4. Exterior ladders shall be galvanized.

H. Steel Safety Cage at Ladder: 2" x 3/8" Verticals at 6" o.c., welded to 5" x 3/8" hoops at 4'-0" o.c., horizontally.

I. Aluminum Ladders:
   1. Basis of Design Products: Design for access ladders are based on O'Keefe's Inc. Subject to compliance with requirements, provide the named products or approved equal products by another manufacturer.
      a. Heavy Duty Vertical Ladder at Roof Hatch: O'Keefe's Model 501.
      b. Heavy Duty Vertical Low Parapet Roof Access Ladder (No platform, no return): O'Keefe's Model 503A.
      c. Heavy Duty Over-Parapet Roof Access Ships Ladder with platform and return: O'Keefe's Model 522. Set on roof equipment curbs, with attachment penetrations through vertical faces of cap. Refer to Division 07 Section "Roof Accessories" for equipment curbs.
   2. Space siderails of ladders min. 16 inches apart unless otherwise indicated.
   3. Siderails: Continuous extruded-aluminum tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
   4. Rungs: Extruded-aluminum tubes, not less than 1-1/4 inch deep and rated for 1500 lb, with anti-slip serrated, ribbed, or abrasive tread surfaces. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
   5. Support each ladder at top and bottom and not more than 60 inches o.c. vertically, with welded or bolted aluminum brackets.
   6. Finish: Mill Aluminum
   7. Safety Ladder-Up Extension Post: Refer to Division 07, Section "Roof Accessories."

J. Expansion Joint Covers: Extruded aluminum anchored to wall, floor and ceiling per manufacturer's instructions. Expansion joint covers shall be as follows, or approved equal:
   1. Interior Ceiling to Wall: Balco/Metaline #AC-15.
   2. Interior Wall to Wall: Balco/Metaline #GP-10.

3. Interior Floor to Floor: Balco/Metaline #NBS-10.
4. Interior Ceiling to Ceiling: Balco/Metaline #AC-10.

K. Countertop Support Frames: Provide welded steel support frame for wide countertops without intermediate supports as indicated in Drawings, and as indicated in Division 6, Section - Architectural Woodwork. Provide steel tube posts located inside adjacent wall framing, with steel tube, channel, or angle horizontal beneath countertop as indicated in Drawings. Steel sizes indicated in Drawings are minimum sizes allowed; provide larger sizes where required to meet performance criteria and delegated design. The depth of the horizontal member must be designed to fit concealed behind the front vertical side of the countertop. Design connection to floor slab to support indicated loading and to fit within wall framing dimensions. Pre-drill for screw attachment / connection of countertop underlayment as directed by millwork fabricator / installer.

L. Miscellaneous Equipment Supports: Field verify all dimensions and provide miscellaneous steel support structure for wall and ceiling mounted equipment as follows:
1. For ceiling mounted projector mounts, and locations and items as specifically detailed or other items called for in the Drawings or other Sections requiring miscellaneous steel supports for complete installation.
2. For large ceiling fans as indicated in Drawings.
3. Where not specifically detailed, design and provide supports as required for all other equipment to be provided or installed under this contract.
4. All supports shall comply with requirements of the equipment Manufacturer(s) for support structure and shall provide adequate strength and secure attachment to building structure, braced against lateral movement.

M. Metal Gratings:
1. Cast Iron Grating at Trench Drains: Re: Division 25 Section - Plumbing and 33 Section - Utilities.

N. Sidewalk Culvert: 3/8" galvanized checkerplate sidewalk culvert cover with countersunk screws.

O. Sidewalk Trench Cover & Frame: Standard support frame and bolted down solid checkered top of Gray Iron, Class 35 shall be Neenah Foundry Co., "Light Duty" Series #R-4991 with Type D skid resistant top, or approved equal by Barry Pattern & Foundry, Campbell, or McKinley Iron Works, in sizes as shown on drawings.

P. Pipe Guards:
1. Fabricate from 1/4" bent steel plate, in shapes as indicated on drawings. Or where not indicated, bent to fit flat against the wall or column at both ends and to fit around pipe with 2 inch clearance between the pipe and pipe guard. Drill each end for two or more 3/4 inch anchor bolts, spaced 24" on center
2. Height and locations: **[As indicated in Drawings] [from xx" to xx" above floor at exposed vertical [PVC and copper] pipes [other than the sprinkler riser] that are located inside the Apparatus Bay]**.
3. Finish: galvanized.

Q. Downspout Boots:
1. Stainless Steel or Galvanized Steel Downspout Boot (for discharge to below grade pipe): Equal to Piedmont Pipe Downspout Adapter, sized to match downspouts. Coordinate overall lengths of boots with grading plan for below grade connection to drain pipes.

R. Pipe Bollards: 6" Diameter galvanized schedule 40 steel pipe with concrete fill. Mound concrete at top of bollard to shed water.

1. Size: 7'-0" in length, recessed 3'-0" below-grade. 4'-0" height above grade, unless otherwise indicated in Drawings.
2. Paint: Refer to Division 09, Section "Painting". Colors: safety yellow, or as selected by Architect.

S. Cast Iron Wheel Guards: Type WG7 as manufactured by McKinley Iron Works, or approved equal. Provide with 2" diameter x 1/4" plate bolt hole cap plates.

T. Steel Double Swing Gate (Dumpster Enclosure): Tube frame with steel tubes as detailed on drawings. Provide gate frames and posts for fully functional system, equal to Ametco Manufacturing Corp., Willoughby, OH 440-951-4300. Tap drill where required for cladding and hardware installation.
   1. Gate Hardware: As shown in Drawings, and as follows:
      a. Hinges: Heavy Duty gate hinges, structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall be offset and permit gate to swing at least 120°. Provide three hinges for each leaf.
      b. Latch: Extra Heavy Duty slide bolt latch with keep, lockable with padlock. (Padlock provided by Owner).
   2. Cane Bolts: Provide heavy duty cane bolt for each leaf.
   3. Metal Gate Panels: As manufactured by Ametco Manufacturing Corp., or approved equal.
      a. Material: Hot-Dipped Galvanized Steel, Gauge as recommended by manufacturer for leaf size.
      b. Infill Panels: Equal to Ametco "Shadow 100" series.
      c. Attachment to Gate Frame: As recommended by manufacturer
   4. Finish for gate frame, posts, and metal panels: hot-dipped galvanized and powder coated, color to be selected by Architect.

U. Metal Canopy Steel: Where custom fabricated metal window canopies are indicated on drawings:
   1. Corrugated Metal Roof Deck: Refer to Structural Drawings for profile, hot-dipped galvanized steel.
   2. Steel Angles: Hot-dipped Galvanized, shop primed and powder-coated to match exterior metals, custom RAL color to be provided by Architect
   3. Steel Plates: Hot-dipped Galvanized, shop primed and powder-coated to match exterior metals, custom RAL color to be provided by Architect
   4. Bolts/Screws: Refer to Structural Drawings, hot-dipped Galvanized steel.

V. Miscellaneous Steel Shapes: Channels, angles, plates, tubing, connections and bolts provided where shown and detailed on drawings. Exterior imbed plates, support angles, and other miscellaneous exterior steel shall be hot-dip galvanized.

2.03 SHOP PAINTING

A. All Iron and Steel Work: Unless otherwise specified, power tool clean all surfaces to remove mill scale. Work shall receive a shop coat of paint before leaving the factory or being exposed to the weather. Aluminum work contacting dissimilar metals shall receive a protective coating preventing galvanic action.

B. Shop Paint: Shop paint shall be Fabricator's standard, fast curing, lead free, "universal" primer, compatible with finish paint system indicated and for capability to provide sound foundation for field applied topcoats.

C. Aluminum surfaces to be in direct contact with concrete and masonry shall be shop coated with zinc chromate primer.

PART 3 - EXECUTION

3.01 FABRICATION

A. Contractor shall secure and be responsible for all field measurements required for the proper and accurate fabrication and installation of the items included under this section; field alterations will not be permitted except upon specific authorization of the Architect.

B. All work shall be assembled in the most substantial manner and reinforced where necessary with structural shapes, using concealed screws, bolts or similar fastenings. Make welds of adequate strength and durability, jointing tight, clean and smooth, flush and in true plane with base metals.

C. All screws or rivets shall be countersunk, unless otherwise noted. Provide lock washers for all bolts.

D. All steel to which wood blocking is connected shall be properly punched for anchoring blocking.

E. Exposed steel shapes with marred surfaces shall be ground or draw-filled to a fine grain finish, as approved before applying shop coat of paint.

F. Assembled work shall be completely constructed in the shop, accurately finished and the pieces match-marked for erection. Form exterior joints to exclude water, grind connections in exposed pieces smooth and polish.

G. The Contractor shall do all drilling, cutting, tapping and fitting of work to accommodate other work coming in contact with it, and shall furnish all taps, bolts and other fittings in connection therewith.

H. Except where otherwise noted, fastening to concrete, solid masonry or hollow masonry shall be with expansion bolts or anchors. Fastening to wood plugs will not be permitted. Toggle bolts may be used only when approved by the Architect.

3.02 INSTALLATION, GENERAL

A. All work included in this Contract shall be installed by the Contractor at the proper time and as rapidly as the progress of the adjacent and connecting work will permit.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true to line, and free of rack; and measured from established lines and levels.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Field Welding:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

5. Touch-up shop prime coats.

F. Immediately after erection, clean the field welds, bolted connections, and abraded areas of shop priming. Paint the exposed areas with same material used for shop priming.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.03 INSTALLATION, SPECIFIC ITEMS

A. Miscellaneous Framing and Supports:
   1. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
   2. Anchor supports securely to and rigidly brace from building structure.

B. Nosings and Treads:
   1. Center nosings on tread widths unless otherwise indicated.
   2. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
   3. Unless otherwise indicated, install nosings as wide as possible, equal length on each step, and with ends of nosings installed in line at each stair.

C. Metal Pipe Bollards:
   1. Anchor bollards in concrete. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard for positive drainage away from bollard base.
   2. Fill bollards solidly with concrete, mounding top surface to shed water.
   3. Paint bollards color(s) as approved by architect.

D. Parking Garage Cable Barrier System: Anchor to concrete substrates per design engineer's instructions. Coordinate all anchorages prior to concrete forming.

E. Steel Gates:
   1. Install gates square and plumb. Adjust tension on truss rod as required, after gate cladding is installed.
   2. Install with all gate hardware as specified, or where not detailed with same hardware as specified in Division 32, “Ornamental Metal Fencing and Gates".

3.04 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Rooftop equipment bases and support curbs.
   2. Wood blocking, cants and nailers.
   3. Wood furring and grounds.
   4. Wood sleepers.
   5. Plywood.

B. Related Requirements:
   1. Division 3 Section “Concrete Formwork.”
   2. Division 5 Section “Miscellaneous Metals.”
   3. Division 6 “Architectural Woodwork.”
   4. Division 8 “Hollow Metal Doors and Frames.”
   5. Division 8 “Wood Doors.”
   6. Division 8 “Finish Hardware.
   7. Division 9 “Paint.”
   8. Division 10 “Toilet Accessories.”

1.03 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Timber: Lumber of 5 inches nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   1. NeLMA: Northeastern Lumber Manufacturers' Association.
   2. NLGA: National Lumber Grades Authority.
   3. RIS: Redwood Inspection Service.
   4. SPIB: The Southern Pine Inspection Bureau.
   5. WCLIB: West Coast Lumber Inspection Bureau.
   6. WWPA: Western Wood Products Association.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.05 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Powder-actuated fasteners.
5. Expansion anchors.
6. Metal framing anchors.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
1. Dimension lumber framing.
2. Timber.
3. Laminated-veneer lumber.
4. Parallel-strand lumber.
5. Miscellaneous lumber.

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
4. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

D. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.02 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat all rough carpentry unless otherwise indicated and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.03 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
   3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
   4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841. For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
   1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by testing agency.

E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all rough carpentry unless otherwise indicated, and the following:
   1. Framing for raised platforms.
   2. Framing for stages.
   3. Concealed blocking.
   4. Framing for non-load-bearing partitions.
   5. Framing for non-load-bearing exterior walls.
   6. Roof construction.
   7. Plywood backing panels.

2.04 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions:
   1. Application: Interior partitions not indicated as load-bearing.
   2. Species:
      a. Hem-fir (north); NLGA.
      b. Mixed southern pine; SPIB.
      c. Spruce-pine-fir; NLGA.
      d. Hem-fir; WCLIB, or WWPA.
      e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
      f. Northern species; NLGA.
      g. Eastern softwoods; NeLMA.
      h. Western woods; WCLIB or WWPA.

2.05 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   4. Cants.
   5. Furring.
   6. Grounds.
   7. Utility shelving.

B. For items of dimension lumber size, provide Construction or No. 2 and the following species:
   1. Hem-fir (north); NLGA.
   2. Mixed southern pine; SPIB.
   3. Spruce-pine-fir; NLGA.
   4. Hem-fir; WCLIB or WWPA.
   5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
   6. Western woods; WCLIB or WWPA.
   7. Eastern softwoods; NeLMA.

C. For utility shelving, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
   1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine.
   2. Mixed southern pine; No. 1 grade; SPIB.
   3. Spruce-pine-fir (south) or spruce-pine-fir.

D. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
   1. Mixed southern pine; No. 2 grade; SPIB.
   2. Spruce-pine-fir (south) or spruce-pine-fir.
   3. Western woods; Construction or No. 2 Common.

E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.06 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.
   1. Plywood shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.07 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1.

F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
   2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.08 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: 5-1/2” x 3/8” closed cell foam and adhesive backed peel and stick membrane, equal to Protecto Wrap (800-759-9727) “Triple Guard Energy Sill Sealer.”

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

E. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

F. Fastenings for Wall Supported Items: Provide and install 2 x 8 (minimum) x 1 stud space wood blocking, unless specified otherwise at all stud wall areas receiving grab bars, toilet partitions, wall bumpers and other wall mounted accessories.

G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

H. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- thickness.
   3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
   4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.

I. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
   3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

K. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

L. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
   1. Comply with fastener patterns where applicable.
   2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
   3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.02 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

D. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- size furring horizontally and vertically at 24 inches o.c.

C. Furring to Receive Gypsum Board, Plaster Lath: Install 1-by-2-inch nominal- size furring vertically at 16 inches o.c.

D. Furring to Receive Gypsum Wall Board: Install 2-by-4 nominal furring studs vertically 16 inches o.c.

3.04 ROUGH HARDWARE

A. Provide bolts, screws, anchors, inserts and fastenings required for proper attachment of carpentry and millwork items. Fastenings to concrete or masonry with expansion bolts or anchors. Toggle bolts may be used for hollow masonry. Fastening to wood plugs not permitted. Fastenings spaced 16" o.c. unless otherwise noted.

3.05 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00

SECTION 06 11 00 - WOOD FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Standard Form of Construction Agreement, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Provide rough carpentry, wood framing, trusses, sheathing, and other items normally provided by framing trade and install such items listed herein furnished by other trades.

B. Related Sections include the following:
1. Division 03 Section “Concrete Formwork.”
2. Division 05 Section “Miscellaneous Metals.”
3. Division 06 Section “Rough Carpentry.”
4. Division 06 Section “Pre-Engineered Heavy Timber Trusses.”
5. Division 06 Section “Sheathing.”
6. Division 08 Section “Hollow Metal Door, Frames, and Window Frames.”

1.03 QUALITY ASSURANCE

A. Lumber Standards: Comply with PS 20 and with applicable rules of the respective grading and inspecting agencies for species and products used.

B. Plywood Product Standards: Comply with PS 1 (ANSI A 199.1) or, for products not manufactured under PS 1 provisions, with applicable APA Performance Standard for type of panel specified.

C. Framing Members: Shall comply with recommendations of "Manual for House Framing" of National Forest Products Association.

D. Anchor and Nail: Shall comply with "Recommended Nailing Schedule of Manual for House Framing" and other recommendations of N.F.P.A.

E. Pre-fabricated Wood Members: Comply with design standards for manufactured products set forth in CABO Report No. NER-200 and NER-126.

1.04 SUBMITTALS

A. Comply with pertinent provisions of Division 01 Section “Submittal Procedures”, unless otherwise indicated.

B. Wood Treatment Data: Submit treatment manufacturer's instructions for proper use of each type of treated material. Include certification by treating plant stating chemicals and process used, net amount of preservative retained and conformance with applicable standards. Include statement that moisture content of treated materials was reduced to a maximum of 19% prior to shipment.

C. Prefabricated Wood Trusses: Submit calculations and engineering data.

D. Pre-fabricated Wood Joists:
1. Submit shop drawings showing framing system and joist spacing, loads and joists camber, bearing and anchor details, bridging and bracing and framed openings. Include design calculations and engineering data.
2. Submit manufacturer’s installation instructions.

E. Material Certificates: Where dimensional lumber is provided to comply with minimum allowable unit stresses, submit listing of species and grade selected for each use and submit evidence of compliance with specified requirements. Compliance may be in form of a signed copy of applicable portion of lumber producer's grading rules showing design values for selected species and grade. Design values shall be as approved by the Board of Review of American Lumber Standards Committee.

1.05 HANDLING, DELIVERY AND STORAGE

A. Keep materials dry at all times. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and plywood, and provide air circulation within stacks.

1.06 COORDINATION

A. Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.

PART 2 - PRODUCTS

2.01 WOOD MATERIALS

A. Lumber, General:
1. Factory mark each piece of lumber with type, grade, mill and grading agency, except omit marking from surfaces to be exposed with transparent finish or without finish.
2. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.
3. Provide seasoned lumber with 15% maximum moisture content at time of dressing.

B. Framing Lumber & Miscellaneous Lumber (2" through 4" thick and less than 6" wide):
1. For light framing and miscellaneous lumber (furring, grounds, blocking) provide "Stud" grade lumber for stud framing and "Standard" grade for other light framing, any species. The Contractor may, at his option, use Standard Grade throughout.

C. Pre-fabricated Wood Joists: Lightweight roof and floor joists shall be of flange members, web members and adhesives conforming to CABO Report No. NER-200, equal to I-joists as manufactured by Trus Joist Corporation. Install webs in flanges with grain running in vertical direction of joist and butt joined to form continuous web. Pressure form web and fit into groove in center of wide face of flange members. Each joist shall be identified by a stamp indicating joist type, manufacturer's name, and conforming report number. Install webs in flanges with grain running in vertical direction of joist and butt joined to form continuous web. Pressure form web and fit into a groove in center of wide face of flange members.

D. Plywood:
1. Roof Sheathing: Exterior, APA Rated Sheathing, with span rating to suit joist or truss spacing; thickness as noted on drawings.
2. Wall Sheathing: Exterior, APA Rated Sheathing with span rating to suit stud spacing; thickness as noted on drawings.
3. Sub-Flooring: APA Rated Sheathing, Exposure 1, with span rating to suit joist spacing; thickness as noted on drawings.
4. Backing Panels at Telephone and Electric Equipment: Provide C-D-INT-APA plywood with exterior glue, 1/2" thick.

E. Structural Framing (2" through 4" thick and 6" or wider):
1. For structural framing, provide a Grade of any species which meets or exceeds an "Fb" (minimum extreme fiber stress in bending) of 1200 psi and an "E" (minimum of elasticity) of 1,200,000.

F. Pressure Treated Wood Sills: Blocking, furring, stripping and similar concealed members in contact with masonry or concrete, wood cants, nailers, curbs, blocking, stripping and similar members in connection with roofing, flashing, vapor barriers,

and waterproofing, shall be pressure treated using water-borne preservatives complying with AWPB LP-2. After treatment, kiln dry to a max. moisture content of 15%. Coat cut surfaces with same chemical used for treatment. Creosote or oil borne preservatives are prohibited.

2.02 MISCELLANEOUS MATERIALS

A. Provide metal hangers and framing anchors equal to Simpson Strong Tie as indicated on drawings or approved equal.

B. Fasteners: Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices.

C. Fasteners in Concrete & Masonry: Shall be approved "Wej-It" expansion shields set in properly drilled holes or "Redhead" self-drilling anchors and machine bolts.

D. Where rough framing work is exposed to weather or in ground contact, provide fasteners and anchorages with a hot-dip zinc coating (ASTM A153).

E. Sill-Sealer Gaskets: 5-1/2” x 3/8” closed cell foam and adhesive backed peel and stick membrane, equal to Proteco Wrap, “Triple Guard Engergy Sill Sealer.”

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions where wood frame construction is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until satisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect.

3.02 INSTALLATION

A. General:
1. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
2. Protect all material from weather and handle with care.
3. Set carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
4. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required by recognized standards. Countersink nail heads on exposed carpentry work and fill holes.

a. Use common wire nails, except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; pre-drill as required.

B. Wood Framing, General:

1. Provide framing members of sizes and on spacings shown, and frame openings as shown, or if not shown, comply with recommendations of "Manual for House Framing" of National Forest Products Association.
2. Do not splice structural members between supports.

C. Stud Framing:

1. General: Provide stud framing where shown. Unless otherwise shown, use 2" x 4" wood studs spaced 16" O.C. with 4" face perpendicular to direction of wall or partition. Provide single bottom plate and double top plates 2" thick by width of studs; except single top plate may be used for non-load bearing partitions. Nail or anchor plates to supporting construction.
2. Construct corners and intersections with not less than 3 studs. Provide miscellaneous blocking and framing as shown and as required for support of facing materials, fixtures, specialty items and trim.
3. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Set headers on edge and support on jamb studs.
   a. For non-bearing partitions, provide double-jamb studs and two 2" x 6" headers with plywood flitch.
   b. For load-bearing partitions, provide double-jamb studs for openings 6' and less in width, and triple-jamb studs for wider openings. Provide headers of depth shown, or if not shown, provide as recommended by N.F.P.A., "Manual for House Framing".

D. Pre-fabricated Wood Joist Framing:

1. Material shall be erected and installed in accordance with the plans, shop drawings and manufacturer's installation instructions. Temporary construction loads which cause stresses beyond design limits are not permitted. Place permanent bridging, bracing and anchors to maintain joists straight and in correct position before installation of decking. Holes, cuts or notches not previously approved by joist engineering shall not be permitted. The final erection shall be under the direction of qualified construction supervisor.
2. Connections: Lateral nail holding and withdrawal are as provided in the code for Douglas Fir sawn lumber. Nails installed parallel to the glue lines on the narrow face shall not be spaced closer than four inches for 10-penny common nails and three inches for 8-penny common nails. Nails installed perpendicular to the glue lines on the wide face shall be installed in accordance with the code. These nailing specifications are based on a member at least ¾" thick and 3-1/2" wide. Holding

power of bolts installed perpendicular to the glue lines is as provided in the code for dense Douglas Fir.

E. Joist Framing:

1. General: Provide framing of sizes and spacings shown. Install with crown edge up and support ends of each member with not less than 1-1/2" of bearing on wood. Attach to wood bearing members by toe nailing or metal connectors, or both; frame to wood supporting members with wood ledgers as shown, or if not shown, with metal connectors. Frame openings with headers and trimmers; double headers and trimmers where span of header exceeds 4'. Do not notch in middle third of joists; limit notches to 1/6 depth of joist, 1/3 at ends. Do not bore holes larger than 1/3 depth of joist or locate closer than 2" from top or bottom. Provide solid blocking (2" thick by depth of joist) at ends of joists unless nailed to header or brand member.
2. Lap members framing from opposite sides of beams, girders or partitions not less than 4" or securely tie opposing members together. Provide solid blocking (2" thick by depth of joists) over supports.
3. Anchor members paralleling masonry with 1/4" x 1-1/4" metal strap anchors spaced not more than 8' O.C. Extend anchors at least 4" into masonry, turn up 4" and extend over and fasten to 3 joists.
4. Under jamb studs at openings, provide solid blocking between joist.
5. Under non-load bearing partitions, provide double joists separated by solid blocking equal to depth of studs above. Provide triple-joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures, unless otherwise shown.
6. Provide bridging between joists where nominal depth-to-thickness ratio exceeds 4, at intervals of 8'. use bevel cut 1" x 4" or 2" x 3" wood bracing, double-crossed and nailed both ends to joists, or use solid wood bridging 2" thick by depth of joist, end nailed to joist.

F. Rafter and Ceiling Joist Framing:

1. Ceiling Joists: Provide member size and spacing shown, and as previously specified for joist framing. Face nail to ends of parallel rafters.
2. Rafters: Provide member size and spacing shown. Notch to fit exterior wall plates and toe nail or use special metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
    a. At valleys, provide valley rafter of size shown, or if not shown, provide rafter twice as thick as regular rafters and 2" deeper. Bevel ends of jack rafters for full bearing against valley rafter.
    b. At hips, provide hip rafters of size shown, or if not shown, provide of same thickness as regular rafters and 2" deeper. Bevel ends of jack rafters for full bearing against hip rafters.

3. Provide collar beams (ties) as shown, or if not shown, provide 1" x 6" boards between every third pair of rafters. Locate below ridge member, on-third of distance to ceiling joists. Cut ends to fit slope and nail to rafters.
4. Provide special framing as shown for eaves, overhangs, dormers and similar conditions, if any.

G. Trussed Rafters:
1. General: Provide trussed rafters where shown. Comply with the applicable requirements of the NLMA's, "National Design Specifications for Stress Graded Lumber and Its Fastenings", and the Truss Plate Institute's, "Light Metal Connected Wood Trusses".
2. Provide pre-engineered and shop-assembled trusses designed for the span, loading, truss shape and spacing shown. Fabricate in the plant of the manufacturer or his licensed fabricator.
3. Erect trusses in accordance with manufacturer's printed instructions. Provide temporary supports and bracing as required.

H. Plywood Roof Sheathing:
1. Provide plywood roof sheathing as required. Install with long dimension across supports, using panels continuous over 2 or more spans with end joints between panels staggered and located over center of supports.
   a. Refer structural drawings for nailing, spacing, and patterns.
   b. Provide support at unsupported long edges with "Plyclips" or wood blocking.
2. Allow 1/8" open space between end joints and 1/4" open space between edge joints for expansion and contraction of panels.

I. Plywood Wall Sheathing:
1. Provide plywood wall sheathing. Install horizontally or vertically using panels continuous over 2 or more spans. Nail edges and ends over supports at 6" O.C. and at 12" O.C. over intermediate studs, using 6d nails for panels not more than 1/2" thick and 8d nails for thicker panels or as noted on plans. Allow 1/8" spacing at panel ends and 1/4" at panel edges.
2. Refer to structural drawings for Plywood shear wall installation requirements.
3. Over all new sheathing apply one layer of building paper/wrap as specified herein.

J. Plywood Flooring:
1. Sub-Floor: Install with the long dimension of the panel across supports and with panel continuous over two or more spans. Panel end joints shall occur over framing. Allow 1/8" spacing at panel ends and 1/4" at panel edges. Nail 4" O.C. along panel edges and 10" O.C. at intermediate supports and blocking with 6d common nails for 1/2" panels, 8d for greater thicknesses, or as noted on plans. Where panels are 1-1/8" or 1-1/4" thick and supports are 48" O.C., nails shall be 8d ring-shank or 10d common and space 6" O.C. at all supports.

K. Nailing: Where driving of nails causes splitting, holes for nails shall be sub-drilled. The following is the minimum schedule for common wire nails:

1. Double Top and Sole Plates: Lower member to studs - 2 - 16d; upper member to lower, staggered - 16d at 12"; at intersection - 3 - 16d.
2. Blocking Between Studs: End nail, each end - 2 - 16d and/or toe nail, each end - 2- 8d.
3. Ribbons to Studs: 1" - 2 - 8d.
4. Multiple Studs: For widths over 4", stagger - 16d at 12".
5. Studs to Bearings: Toe nails, each side - 2 - 8d.
6. No staples will be permitted as a substitute for nails.

3.03 CLEAN UP

A. Upon completion of work of this section, remove related debris from premises.

END OF SECTION 06 11 00

SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Roof sheathing.
   3. Sheathing joint and penetration treatment.

B. Related Requirements:
   1. Division 06 Section - Rough Carpentry for plywood backing panels and wood floor decking and underlayments.
   2. Division 07 Section - Air Barriers for water-resistive barrier applied over wall sheathing.
   3. Division 07 Section - Metal Wall and Roof Panels.
   4. Division 07 Sections for roofing types over roof sheathing.
   5. Division 07 Section - Sheet Metal and Flashing.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
   3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.04 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:
   1. Preservative-treated wood panel products.
   2. Fire-retardant-treated wood panel products.
   3. Foam-plastic sheathing.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

2.02 PRESERVATIVE-TREATED WOOD PANEL PRODUCTS

A. Preservative Treatments by Pressure Process: AWPA U1 for uses indicated; and as follows:
   1. Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   2. At treated materials in contact with metal, use only non-corrosive type preservatives or provide separation between metal surfaces and materials treated with corrosive chemicals.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.03 WALL SHEATHING

A. Plywood Wall Sheathing:
   1. Nominal Thickness: Not less than 1/2 inch, and not less than 3/4 inch at back side of parapet framing above roof. Additionally, comply with minimum thicknesses indicated in structural Drawings.

B. Cementitious Backer Units at exterior tile application: ASTM C 1325, Type A.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. C-Cure; C-Cure Board 990.
      b. Custom Building Products; Wonderboard.
      c. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
      d. USG Corporation; DUROCK Cement Board.
   2. Thickness: As indicated in Drawings.

2.04 ROOF SHEATHING

A. Plywood Roof Sheathing: Exterior Exposure 1 sheathing
   1. Span Rating: Not less than indicated on drawings
   2. Nominal Thickness: As indicated on drawings

2.05 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Unless otherwise noted, for fasteners at ACQ or corrosive treated wood, provide stainless steel fasteners, or fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
   1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
   1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
   2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

G. Screws for Fastening Vented, Insulated Nail Base Sheathing to Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117. Provide washers or plates if recommended by sheathing manufacturer.

2.06 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

B. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

C. Refer to Division 7 Section(s) for joint treatment requirements for liquid applied air barrier membranes.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work. Unless otherwise indicated, fit tightly against abutting construction, except provide a 3/8” setback where non-load-bearing construction abuts structural elements.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Use common wire nails for attaching sheathing to wood framing unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through the completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when precipitation is forecast.

3.02 CEMENTITIOUS BACKER UNIT INSTALLATION

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

END OF SECTION 06 16 00

SECTION 06 17 53 – SHOP FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Standard Form of Construction Agreement, including General and Special Conditions and Division 01 Specification Sections, apply to this Section

1.02 SUMMARY

A. Section Includes: Furnish labor, material, services, equipment and appliances required for prefabricated wood truss work indicated on the Drawings and specified herein.
   1. Wood trusses
   2. Bridging
   3. Temporary and permanent bracing
   4. Related hardware (as required) and including:
      a. Metal hangers
      b. Anchors
      c. Special metal shapes

B. Related Sections include the following:
   1. Division 06 Section “Rough Carpentry”
   2. Division 06 Section “Sheathing”
   3. Division 06 Section “Wood Framing”

1.03 ENGINEERING DESIGN

A. Trusses shall be custom designed to fit dimensions and loads indicated on the Drawings. Design shall be in accord with allowable values assigned by the most restrictive governing code. Complete design calculation showing internal layout member forces and stress control points are to be submitted to the Architect. Design shall be under the supervision of a registered professional engineer.

1.04 QUALITY STANDARDS

A. Trusses shall be manufactured in a plant approved for fabrication by the Owner.

B. The standards of Automated Building Components, Inc. for quality, engineering and fabrication shall govern the work of the section.

C. National Forest Products Association (NFPA): "National Design Specifications for Stress Grade Lumber and Its Fastenings."

D. American Institute of Timber Construction (AITC): "Timber Construction Standards".

E. Truss Plate Institute (TPI): "Design Specifications for Light Metal Plate Connected Wood Trusses".

F. American Society for Testing Materials (ASTM)

1.05 SHOP DRAWINGS

A. Comply with pertinent provisions of Division 01 Section “Submittal Procedures”, unless otherwise indicated.

B. Submit shop drawings bearing the seal of a professional engineer, licensed in the State of Texas, showing:
   1. Pitch, span, camber, dimensions and spacing of truss.
   2. Truss bearing sizes and locations.
   3. Design loading of truss and allowable stress increase.
   4. Axial forces in each truss member.
   5. Nominal sizes and location of connector plates at all joints.
   6. Size, species and stress of grade of lumber for all truss members.
   7. Permanent lateral bracing as required by design to reduce buckling length of individual truss members only.
   8. Handling and erection recommendations.

C. Submit design calculation for each truss sealed by a registerd professional engineer licensed in the State of Texas.

PART 2 - PRODUCTS

2.01 ITEMS TO BE PROVIDED

A. Prefabricated Wood Truss: Products designed and approved by Automated Building Components or approved equal.

2.02 FABRICATION

A. General: Components shall be fabricated in a properly equipped manufacturing facility of a permanent nature. They shall be manufactured by experienced workmen, using precision cutting and truss fabricating equipment, under the direct supervision of a qualified foreman. All trusses shall be fabricated under strict rules of inspection and quality control required by governing authority.

B. Cutting Members: Accurately cut to length, angle and true to line to assure tight joints for finished truss.

C. Connections: Properly place members and connectors in special jigs and tightly clamp members in place until the connector plates have been pressed into the lumber simultaneously on both sides of the joints.

D. Camber: As noted on accepted shop drawings by properly positioning the members in the fabricating jig.

2.03 MATERIALS

A. Lumber (No. 2 Southern Yellow Pine): Conform to the published stress ratings for the species and grades set out in the official grading rules of the appropriate lumber association or as listed in the reference specifications. Wherever this Specification, or notes on the plans or truss engineering design calls for lumber which exceed the minimum set forth therein, the Specifications, plans and/or truss engineering designs shall be applicable, and information stated or shown in one shall be applicable the same as if in all of them. All lumber shall conform to the species and fully recognized nominal sizes shown on the plans or truss engineering designs. All members shall be cut from lumber which bear the proper grade mark stamps of a recognized grading association or licensed lumber inspection agency. No lumber shall be used which does not appear to conform to the proper dimensions and/or grades. At the time of fabrication, the moisture content of all lumber shall be within limits stated in reference specifications.

B. Connectors:
   1. General: ASTM A446-72 Grade A prime commercial quality galvanized sheet steel of no less than 20 gauge thickness which has a minimum yield of 33,000 psi and a minimum ultimate tensile strength of 45,000 psi. Connectors shall have a series of nail-like projections which are designed to separate the fibers of the wood into which they are pressed, in accordance with accepted nailing practices. All connector plated truss joints shall be designed using the net area plating method as set forth in TIP Standards.
   2. Field Connectors: Where field assembly of truss sub-components is necessary, connections shall be in accord with details shown on accepted shop drawings.

C. Bracing: As required by accepted shop drawings.

D. Hardware: As required by accepted shop drawings.

PART 3 - EXECUTION

3.01 HANDLING

A. Perform in a manner to prevent bending, warping, twisting or other damage.

3.02 STORAGE

A. Store in a vertical position above ground on suitable supports and braced to prevent bending and/or tipping over.

3.03 PROTECTION OF MATERIALS

A. Protect from damage when stored at the job site. Finished members shall be free of bends, twists or open joints. Replace warped, bowed or damaged trusses at no additional cost to the Owner.

3.04 WORKMANSHIP

A. Use only skilled and experienced personnel.

3.05 ERECTION

A. Erect in complete accord with the plans and accepted shop drawings. Provide erection bracing in addition to specified bridging to keep trusses straight and plumb and to assure adequate lateral support for the individual trusses and entire system until decking material has been applied.

3.06 PROTECTION OF WORK IN PROGRESS

A. Apply no construction loads before trusses and bridging have been anchored. Install and secure permanent decking before applying full design loads.

3.07 CLEAN-UP

A. Upon completion of work of the Section, remove related debris from premises.

END OF SECTION 06 17 53

SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Stairwork
   2. Wood cabinets and millwork
   3. Plastic-laminate countertops.
   4. Solid surface Quartz countertops.
   5. Closet and utility wood shelving.
   6. Shop finishing of interior woodwork.

B. Related Sections include the following:
   1. Division 05 Section - Metal Fabrications for metal railings, handrail brackets and miscellaneous steel as required to support countertops.
   2. Division 06 Section - Rough Carpentry for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
   3. Division 06 Section - Quartz Countertops.
   4. Division 07 Section - Joint Sealants for sealing around architectural woodwork and countertops.
   5. Division 09 Section Resilient Base and Accessories for rubber base installed at cabinet base boards.
   6. Division 11 Section - Residential Appliances for appliances installed in millwork and under countertops.
   7. Division 22 Sections for plumbing fixtures and fittings.
   8. Division 26 Sections for electrical devices installed in architectural woodwork.

1.03 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

B. Transparent Finish: Wood finish with exposed grain, including both stained and unstained finishes in colors as selected by Architect, with clear or translucent protective finish coat(s).

C. Rough carriages, stringers, treads, and risers for stairs are a part of interior architectural woodwork. Platform framing, headers, partition framing, and other rough framing associated with stair work are specified in Division 06 Section - Rough Carpentry.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials.
   1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   1. Show details at not less than 1-1/2" scale. Submittal format shall be 30" x 42" sheets.
   2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   3. Show locations and sizes of cutouts and holes installed in architectural woodwork and countertops.
   4. Show arrangement of splashes at countertops.
   5. Apply WI-certified compliance label to first page of Shop Drawings.

C. Samples for Initial Selection:
   1. Shop-applied transparent finishes.
   2. Plastic laminates.
   3. PVC edge material.
   4. Solid-surfacing materials.

D. Samples for Verification:
   1. Veneer-faced panel products with or for transparent finish, 8 by 10 inches, for each species and cut. Include at least one face-veneer seam and finish as specified.
   2. Lumber and panel products with shop-applied finish, 50 sq. in. for lumber and 6 by 8 inches for panels, for each finish system and color, with exposed surface finished.
   3. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish with 1 sample applied to core material
   4. Solid-surfacing materials (including Quartz), 6 inches square.
   5. Corner pieces as follows:
      a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
      b. Miter joints for standing trim.
   6. Exposed cabinet hardware and accessories, one unit for each type.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Product Certificates: For each type of product, signed by product manufacturer.

C. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.06 QUALITY ASSURANCE

A. Materials and Fabrication, General:
   1. Provide Custom Grade for transparent (stained) finish, per AWI standards. Casework and Cabinetry shall be of reveal overlay design, unless otherwise specified or indicated on drawings.
   2. Casework shall minimally meet AWI Section 400A standards for transparent finished custom grade casework.
   3. All dimensions, substrates, etc. shall be verified in the field by the Contractor.
   4. Use maximum length material for all trim, base, etc.
   5. Scribe and fit all cabinets and casework tightly to adjoining construction unless otherwise indicated.

B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
   1. Fabricator shall have had at least 5 years experience in projects of similar scope.

C. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

D. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and transparent-finished wood doors that are required to be of same species as woodwork.

E. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
   1. Provide AWI Quality Certification Program certificates indicating that woodwork**,** including installation, complies with requirements of grades specified.

F. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section - Project Management and Coordination.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
   2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.09 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

B. For appliances and equipment attached to or adjacent to millwork, coordinate required clearances and rough openings, prior to fabrication and prior to installation of cabinets.
   1. Prior to fabrication of millwork, Contractor to verify that appliance doors, handles, and controls do not conflict with doors and drawers of adjacent millwork, and adjust millwork dimensions or provide filler strips as required to allow full 90° opening of all doors, and full opening of drawers. Coordinate prior to utility rough in where solution involves changing the location of appliances.

C. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section - Door Hardware (Scheduled by Describing Products) to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

1.10 WARRANTIES

A. Quartz countertop manufacturer's standard 10-year warranty against material defects.

B. Architectural Woodwork installer's 1-year warranty against all defects in material and installation.

1.11 EXTRA MATERIALS

A. Provide additional shelf brackets for adjustable cabinet shelves, minimum of one additional bracket per cabinet section with adjustable shelves, in manufacturer's unopened packages.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Certified Wood: Interior architectural woodwork shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

C. Wood Species and Cut for Transparent Finish: White oak, rift sawn or cut

D. Wood Products: Comply with the following:
   1. All lumber shall be kiln dried to a moisture content of 4-1/2 percent. Kiln dried lumber shall be tempered for not less than four weeks before using.
   2. Hardboard: AHA A135.4.
   3. Medium-Density Fiberboard: ANSI A208.2, Grade MD
   4. Particleboard: ANSI A208.1, Grade M-2
   5. Softwood Plywood for Laminate finish: DOC PS 1, at semi-exposed surfaces unless noted otherwise.
   6. Medium Density Overlay Plywood (MDO): APA PS1-09, Exterior Grade B-B, MDO plywood.
   7. Medium Density Fiberboard Combination Core Plywood: Panels constructed of veneer core plywood inner plies with phenolic-bonded MDF crossbands with PureBond® formaldehyde-free technology; Classic Core as manufactured by Columbia Forest Products, or approved equal.

a. Panels made of particle board, MDF, Plywood, and combination core with lumber core instead of plywood core are not acceptable substitutions for the combination core panels as specified.

8. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1
   a. Use Combination Core panels at doors and drawer fronts and exposed end panels unless otherwise noted. See Combination Core requirements above.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates as scheduled in the drawings

2.02 CABINET HARDWARE AND ACCESSORIES

A. General:
   1. All hardware and accessory materials associated with architectural cabinets provided and installed by cabinet fabricator.
   2. Finish for Exposed Cabinet Hardware (Typical unless otherwise noted): Stainless Steel
   3. Finish for Concealed Cabinet Hardware (Typical unless otherwise noted): as selected by Architect from Manufacturer's available finishes.
   4. Provide all screws, fasteners, and miscellaneous hardware and attachments as required for complete installation.

B. Hinges:
   1. Butt Hinges: 2-3/4-inch, 5-knuckle steel hinges made from 0.095-inch- thick metal.
      a. Provide hinges designed for thick doors where thick or hollow core doors are detailed in Drawings.
   2. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening**,** self-closing, soft-closing.
      a. Provide four (4) hinges per leaf at tall cabinet doors.
      b. Provide hinges designed for thick doors, where thick or hollow core doors are detailed in Drawings.
      c. At combination core plywood, provide hinges with screws of the optimal length to make best advantage of screw pulling strength of the plywood core, regardless of whether the optimal screw length comes standard with the hinges.
   3. Flipper door slide hinge for fold-away doors at ADA base cabinets adjacent to range/oven: Equal to Accuride Flipper door slide 123 with Overlay style hinge hardware kit. Provide correct size kit for door dimensions and weight. Provide magnetic door catches.
   4. Scissor Hinge for Sink-Front Panel: Equal to Knape and Vogt SH-1-S/P.
      a. Coordinate with electrical contractor for installation of electrical switch for disposer, to be located behind sink panel inside of cabinet, to the left side of the kitchen sink.

C. Cabinet Pulls:
   1. Bar Pulls (Cabinet Doors): Satin stainless steel rod pulls, equal to Mockett DP55D.
   2. Bar Pulls (Cabinet Drawers) Satin stainless steel rod pulls, equal to Mockett DP55B.

D. Door and Drawer Locks: Verify keying with Owner prior to ordering locks. Provide 2 keys per lock unless otherwise noted.
   1. Combination Cam Locks: As manufactured by Combi-Cam, or equal. Cam configuration to suit applications.

2. Provide wood lockers with combination cam locks with key override, equal to Combi-Cam Ultra 7440.

E. Catches (At non-locking doors and drawers): No catches (European style hinges hold doors in closed position).

F. Adjustable Shelf Pilasters and Supports in Cabinets: Four Flush-mounted 23 gauge high strength steel, zinc finish pilaster standards adjustable to 1/2" increments, equal to Knape and Vogt Series 233.
   1. Provide an additional surface mounted Pilaster at all shelves wider than 36", at the middle back of shelf, equal to Knape and Vogt Series 233.
   2. Provide longest possible standards to fit full height of cabinets, using manufacturer's standard lengths.
   3. Provide square, self-adhesive felt pads at glass shelves.
   4. Provide all installation hardware, and support brackets equal to Knape and Vogt 237 series, as required for complete installation. Provide additional support brackets as specified in Part 1 of these specifications.

G. Drawer Slides: Zinc-plated steel drawer slides with steel ball bearings and as follows:
   1. Box Drawer Slides (for drawers less than 7" deep): Side mounted; full-extension type; Medium duty, 100 lb rated equal to Knape and Vogt 8400 series.
   2. Deep Storage Drawer Slides: Side mounted; full-overtravel-extension type; Heavy Duty, 200 lb rated, equal to Knape and Vogt 8800 series.
   3. Trash Bin Slides: Soft Closing pull-out trash slide system with white trash bin equal to:
      a. Knape and Vogt USC 12-1-50-WH for single trash bin units.
      b. Knape and Vogt USC-18-2-50-WH for double trash bin units, two sets at kitchen island.

H. Verify monitor arm below is correct size and mounting type for your application. Type below mounts in a hole bored through the countertop. They also come as "clamp-on" type model FSA4/C-23. Laptop drawers, pencil drawers, keyboard drawers, pop-up and flip-up outlets in countertops, CPU under-counter holder brackets, and wire managers are also available from Doug Mockett & Co.

I. Grommets for Cable Passage through Countertops: 3" inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
   1. Product: Subject to compliance with requirements, provide "XG series" by Doug Mockett & Company, Inc.

J. Coat Rod: Heavy Duty 1-1/4" round, chrome finish, metal rod with similar finish and material escutcheons at each end with countersunk holes for attachment to inside of cabinet. Installed to allows rods to be removed and replaced.

K. Coat Hooks:
   1. Coat and hat double hook for mounting in wardrobe cabinets and : Equal to Ives 572.
   2. Top Mounted, double wardrobe hook for mounting in cubbies: Equal to Ives 580.
   3. Side Mounted, single wardrobe hook for mounting in cubbies: Equal to Ives 581.
   4. Side Mounted, double wardrobe hook for mounting in cubbies: Equal to Ives 582.

L. Cabinet Signage:
   1. Provide one stainless steel number plate for each locker cabinet door in bedrooms, verify numbering/sizing requirements with Architect.

M. Adjustable Storage Shelving on Standards:
   1. Double slotted heavy duty standards and brackets with anochrome finish shall be Knape and Vogt No. E85 and E185, or approved equal.

2. Shelves shall be 3/4" stained & varnished hardwood veneer plywood unless otherwise noted.
3. Attach shelves to brackets with screws.

N. Silencers: 1/8" domed clear rubber, self-adhesive pads. Install two per cabinet drawer or door.

2.03 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
1. Conceal all anchors, or otherwise locate as indicated in Drawings and approved by Architect.

C. Desk Support Brackets: Minimum 3/4" hardwood veneer plywood stained to match millwork. Provide as indicated in drawings, or as required to achieve 200 lb. per sq. ft. loading condition, whichever is greater.

D. Adhesives, General: Adhesives shall not contain urea formaldehyde.

E. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. VOC Limits for Installation Adhesives: Installation adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
2. Multipurpose Construction Adhesives: 70 g/L.
3. Contact Adhesive: 250 g/L.

G. Adhesive for Bonding Plastic Laminate: Un-pigmented contact cement
1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.04 LOUVERS

A. Bedroom Locker Air Vent: Provide two of the following per locker cabinet door as indicated on drawings:
1. Mockett ZGAVG2 Air vent grommet cap with ZG1 liner (4" hole), Black.

2.05 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.

B. Solid Stock Standing and Running Trim
1. Species for Transparent Finish: Match species and grain of adjacent panels for transparent finish unless otherwise indicated.
2. Species for Opaque Finish: Any closed grain hardwood.
3. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

C. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

D. Cabinet Construction
   1. Face Frames: Not less than 3/4" x 1-5/8" solid lumber rails and stiles with glued mortise and tenon joints.
   2. Exposed Ends: Not less than 3/4" thick combination core plywood, connected to stile with pressure-glued tongue and plow joint and supplemented by special fasteners.
   3. Semi-Exposed Panel Ends: Not less than 1/2" plywood.
   4. Unexposed Ends: Not less than 1/2" thick plywood attached to front frame in same manner as exposed ends.
   5. Door and Drawer Faces: 3/4" thick combination core plywood.
   6. Back, Top and Bottom Rails: Not less than 3/4" x 3" solid lumber machined to interlock with end panels, and grooved to receive top and bottom panels with back rails secured under pressure with glue and fastening devices.
   7. Shelving: Not less than 3/4" thick hardwood plywood with lumber core banded on front with 3/4" x 1-1/4" hardwood unless shown otherwise.
   8. Bottoms: Not less than 3/4" thick plywood fully supported into gains in end panels and grooves in front frame and back bottom rails.
   9. Back Panels: Not less than 1/4" thick, 5-ply veneer core plywood, glued and fastened to machined rear edge of end panels and to top and bottom rails.
      a. At exposed back panels, provide panels equal to those for exposed end panels and exposed surfaces shall match adjacent cabinet body finish.
   10. Toe Boards: Not less than 3/8" attached between end panels and extended from bottom panel to floor.
   11. Corner Blocks: Wood blocks glued and fastened in each of four top corners to maintain cabinet squareness and rigidity.
   12. Casework Doors: 3/4 inch thick hardwood veneer combination core plywood with hardwood veneer banded edges. At full height cabinet doors (larger than standard base cabinets), use 1" thick combination core.

E. Drawer Construction
   1. Drawer Body: Not less than 7/16" plywood sub-front, back and sides, fully dovetailed and glued at all four corners with fronts fastened to sub-front with mounting screws from interior of body.
   2. Drawer Bottoms: Not less than 1/4" thick 5-ply veneer core plywood glued into and fully supported by grooves in all four sides of drawer body.

F. Laminate Countertops and Splashes: Constructed from one continuous sheet of laminated plastic without intermediate joints, to the greatest extent possible. Provide cut-outs for sinks and other accessories, cut-out radiuses at least for 1/8 inch with edges filed smooth and free of crazes.

G. Exposed and Semi-Exposed surfaces shall be machine-sanded to an even, smooth surface, nails set, ready for finishing. All woodwork shall be dry, clean and smooth before any finishing materials are applied. All nail holes, cuts, cracks and other defects shall be treated so as to render them unnoticeable.

H. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch Thick or Less: 1/16 inch.
   2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.

I. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment. Verify cabinet doors and drawers operate freely at inside cabinet corners.

J. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.
   2. Coordinate with actual appliances and equipment to be mounted to cabinets and under countertops, whether such equipment is provided by Contractor or by Owner, and verify unobstructed operation of equipment and of cabinet doors and drawers.

K. Countertops and Splashes:
   1. Units fabricated and designed to with-stand a 200 lb. per sq. ft. loading condition without the use of vertical supports. Fabricator shall indicate on shop drawings any special locations for stud supports as required for attachment of countertops.
   2. Provide welded steel tube support frames to support countertops at wide spans between base cabinets, walls, or other countertop supports. Conceal steel tubes in adjacent wall, countertop, and cabinet construction to maximum extent possible unless specifically detailed otherwise. Refer to Division 5, Section - Metal Fabrications for general requirements. Provide steel supports as follows:
      a. Where specifically detailed in Drawings.
      b. Where required to achieve loading criteria specified.
   3. Junction between countertops and non-integral splashes caulked with clear silicone sealant providing a tight sanitary joint. Junction between splash, countertop or any casework and wall shall be caulked with silicone sealant of color to match wall or adjacent construction.
   4. Splash of same construction and countertop, to dimensions indicated on drawings. Provide side splashes at all walls and tall cabinets adjacent to countertops.

2.06 WOOD CABINETS FOR TRANSPARENT FINISH

A. Grade: Custom.

B. AWI Type of Cabinet Construction: Reveal overlay

C. Reveal Dimension: As indicated in drawings.

D. Matching of Veneer Leaves: Book match.

E. Exposed Surfaces: Do not juxtapose materials noticeably dissimilar in color, grain, figure and natural color markings. Exposed portions of cabinets include all surfaces, including edges, visible when doors and drawers are closed. Visible surfaces in open cabinets and shelving units are also to be considered exposed surfaces. Provide materials as indicated below:
   1. Doors and Drawer Fronts: 3/4" Panels of Hardwood Veneer on Combination Core Plywood, with hardwood banded edges.
   2. Other Panel Surfaces: Hardwood veneer plywood.

3. Solid Stock: Match panel species and grain.

F. Semi-exposed Surfaces: Transparent wood finish materials selected to eliminate appearance defects of any species of hardwood or softwood with color and grain characteristics similar to exposed portions. Semi-exposed portions of cabinets include surfaces behind opaque doors and drawer fronts including shelves, dividers, interior faces of cabinet ends, backs, tops and bottoms, drawer sides, backs and bottoms. Also, included are underside bottoms of cabinets over 2'-0" from floor and tops 5'-9" or more above floor. Provide surface materials indicated below:
   1. Surfaces Other Than Drawer Bodies: Compatible species to that indicated for exposed surfaces, stained to match.
   2. Drawer Sides and Backs: Hardwood veneer plywood, stained to match species indicated for exposed surfaces
   3. Drawer Bottoms: Hardwood plywood.

G. Concealed Members: Solid Lumber. Concealed portions of cabinets include sleepers, web frames, dust panels and other surfaces not normally visible after installation.

2.07 PLASTIC-LAMINATE COUNTERTOPS

A. High-Pressure Decorative Laminate Grade HSP

B. Colors, Patterns, and Finishes: As scheduled in Drawings.

C. Edge Treatment:
   1. Material: Same as laminate cladding on horizontal surfaces.
   2. Shape: Square edge

D. Core Material at splashes: Constructed of phenolic 45 lb. high-density particle board cores conforming to ANSI A208.1 - 1989, 2M-1

E. Core Material at countertops:
   1. Countertops without sinks: Medium-density fiberboard
   2. Core Material at countertops with sinks: Medium-density fiberboard made with exterior glue.

F. Backer Sheet: Provide melamine balancing sheet on underside of countertop substrate.

G. Core Material at built-in desks: Medium-density fiberboard

2.08 QUARTZ SOLID SURFACE COUNTERTOPS

A. Wood Underlayment Material (where required for support by surface material):
   1. Core Material at countertops: Plywood, or as recommended in writing by Quartz manufacturer.
   2. Core Material at countertops with sinks: Exterior-grade MDO plywood, or as recommended in writing by Quartz manufacturer

2.09 CLOSET AND MISCELLANOUS SHELVING

A. Shelf Material: 3/4-inch hardwood veneer plywood with veneer edge banding.

2.10 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

C. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section.

D. Finishing Materials: Products shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with balancing sheet.

F. Transparent Finish:
   1. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
   2. Staining: Color as Selected by Architect.
   3. AWI Finish System: Conversion varnish.
   4. Sheen: Semi-gloss, 35-70 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing materials and backpriming.

3.02 INSTALLATION

A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Where exposed fastening is unavoidable, use fine finishing nails, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
   1. At trim for transparent finish, fill gaps, if any, between wall and exposed edges of trim and base boards with plastic wood filler, sand smooth, and finish same as wood.

2. At trim for opaque finish, neatly caulk gaps, if any, between trim and wall and paint to match adjacent finish.
3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

H. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening, unless approved by Architect.
1. Install flush paneling with no more than 1/16 inch in 96-inch vertical cup or bow and 1/8 inch in 96-inch horizontal variation from a true plane.

I. Stairs: Securely anchor carriages to supporting substrates.
1. Install stairs with treads and risers no more than 1/8 inch from indicated position.
2. Construct sloped wood risers for 1" nosing, as indicated in drawings.
3. Re: Structural drawings and notes for fastening and loading requirements.
4. Coordinate alignment of dissimilar wall types behind wood stringers, so that the finished surfaces of the walls align with less than 1/8" deviation. Caulk joint between wall and stringer so joint is unnoticeable.

J. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips.

K. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
4. Caulk space between backsplash and wall with sealant specified in Division 07 Section - Joint Sealants.

L. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

M. Refer to Division 09 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

3.03 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 40 23

SECTION 06 61 40 - QUARTZ COUNTERTOPS AND FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Quartz countertops.
   2. Quartz fabrications.
   3. Setting materials and accessories.

B. Related Sections:
   1. Division 06 Section - Rough Carpentry.
   2. Division 06 Section - Architectural Woodwork.
   3. Division 07 Section - Joint sealers.
   4. Division 09 Section - Gypsum Board.

1.03 REFERENCES

A. American National Standards Institute (ANSI):
   1. A108.5 - Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar.
   2. A118.4 - Latex-Portland Cement Mortar.

B. ASTM International (ASTM:
   1. C97 - Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
   2. C99 - Standard Test Method for Modulus of Rupture of Dimension Stone.
   3. C170 - Standard Test Method for Compressive Strength of Dimension Stone.
   4. C241 - Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic.
   5. C482 - Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement.
   6. C484 - Standard Test Method for Thermal Shock Resistance of Glazed Ceramic Tile.
   7. C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   8. C648 - Standard Test Method for Breaking Strength of Ceramic Tile.
   9. C650 - Standard Test Method for Resistance of Ceramic Tile to Chemical Substances.
   10. C672/C672M - Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
   11. C880 - Standard Test Method for Flexural Strength of Dimension Stone.
   12. C1026 - Standard Test Method for Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling.
   13. C1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   14. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.04 QUALITY ASSURANCE

A. Fabricator and Installer Qualifications: Minimum 2 years documented experience in work of this Section.

1.05 SUBMITTALS

A. Shop Drawings: Include countertop layout, dimensions, materials, finishes, cutouts, and attachments.

B. Samples:
   1. Manufacturer's standard size quartz samples in specified color.
   2. Standard sealant colors for selection by architect.

1.06 WARRANTY

A. Provide manufacturer's 10 year warranty against defects in materials and workmanship.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Quartz Sheet:
   1. Product: As scheduled on Drawings, or approved equal.
   2. Composition: Quartz aggregate, resin, and color pigments formed into flat slabs.
   3. Color: To be selected by Architect from manufacturer's full color range, or as indicated on drawings.
   4. Thickness: ¾ nominal.
   5. Physical characteristics:
      a. Static coefficient of friction: 1.02 dry, 0.51 wet, tested to ASTM C1028.
      b. Water absorption: Maximum 0.03 percent, tested to ASTM C97.
      c. Compressive strength: Minimum 29,000 psi, tested to ASTM C170.
      d. Bond strength: Minimum 210 psi, tested to ASTM C482.
      e. Modulus of rupture: Minimum 6300 psi, tested to ASTM C99.
      f. Flexural strength: Minimum 5800 psi, tested to ASTM C880.
      g. Breaking strength: Minimum 480 lbf, tested to ASTM C648.
      h. Stain resistance: Not affected by 10 percent hydrochloric acid or 10 percent KOH, tested to ASTM C650.
      i. Thermal shock resistance: Pass 5 cycles, tested to ASTM C484.
      j. Abrasive index: 65-Ha = 25, tested to ASTM C241.
      k. Thermal expansion: 1.670 x 10^{-5} in/in/deg F, tested to ASTM C531.
      l. Deicing resistance: Rating of 0, tested to ASTM C672/C672M.
      m. Freeze/thaw resistance: 0 tiles at 15 cycles, tested to ASTM C1026.
      n. Flame spread rating: Class 1, tested to ASTM E84.

2.02 ACCESSORIES

A. Adhesive: Type recommended by quartz manufacturer.

B. Joint Sealer:
   1. Latisil Tile and Stone Sealant by Laticrete® International, Inc., or as recommended by Quartz manufacturer in writing.
   2. Color: To be selected by Architect from manufacturer's full color range.

2.03 FABRICATION

A. Cut quartz panels accurately to required shapes and dimensions.

B. Micro-chamfer exposed edges.

C. Fabricate with hairline joints. Minimize joint lines.

D. Cut holes for sinks faucets.

E. Edge Style: micro-chamfer (Eased).

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive countertops; remove loose and foreign matter that could interfere with adhesion.

3.02 INSTALLATION

A. Install countertops in accordance with manufacturer's instructions and approved Shop Drawings.

B. Adhere countertops to supports with continuous beads of adhesive.

C. Set plumb and level. Align adjacent pieces in same plane.

D. Install with hairline joints.

E. Fill joints between countertops and adjacent construction with joint sealer; finish smooth and flush.

3.03 INSTALLATION TOLERANCES

A. Maximum variation from level and plumb: 1/8 inch in 10 feet, non-cumulative.

B. Maximum variation in plane between adjacent pieces at joint: Plus or minus 1/16 inch.

3.04 CLEANING

A. Clean countertops in accordance with manufacturer's instructions.

3.05 PROTECTION

A. Protect installed countertops with non-staining sheet coverings.

END OF SECTION 06 61 40

SECTION 07 11 13 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Cold-applied, emulsified-asphalt dampproofing.
      a. At masonry backup for veneer masonry cavity walls.
      b. At grade beams below grade, with drainage course to french drain.

B. Related Sections include the following:
   1. Division 04 Section - Unit Masonry Assemblies.
   2. Division 07 Section Self Adhering Sheet Waterproofing, for waterproofing system at building grade beams and walls below grade.
   3. Division 07 Sections for other waterproofing, air barrier, and weather barrier systems.
   4. Division 07 Section - Sheet Metal Flashing and Trim.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course molded-sheet drainage panels and auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. BASF Construction Chemicals - Building Systems; Sonneborn Brand Products.
   2. ChemMasters, Inc.
   3. Euclid Chemical Company (The); an RPM company.
   4. Henry Company.
   5. Karnak Corporation.
   6. Koppers Inc.
   7. Malarkey Roofing Products.
   8. Meadows, W. R., Inc.

B. Basis of Design shall be a heavy bodied, non-sag coating with short fibers for application with Fibered Brush, Roller or Spray, in compliance with ASTM D-1227, Type II, Class 1, equal to BASF's "MasterSeal 615".

2.03 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

C. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

D. Patching Compound: Asbestos-free fibered mastic of type recommended in writing by dampproofing manufacturer.

E. Protection Course at grade beams below grade: ASTM D 6506, 1/8-inch- thick, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

F. Protection Course at retaining walls: Smooth-surfaced roll roofing complying with ASTM D 6380, Class S, Type III.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.

C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

3.03 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.
   1. Apply dampproofing to provide continuous plane of protection.
   2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to bottom of grade beam
   1. At footings, extend over top of footing and down a minimum of 6 inches over outside face of footing.
   2. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
   3. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1 inch onto flashing, and 1/4 inch onto masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
   1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
   2. Lap dampproofing at least 1/2 inch onto shelf angles supporting veneer.
   3. At metal flashings installed with termination bar to exterior face of masonry, strip in bituminous felts. Lap felts at least 2" over metal flashing and continuously seal top of felt strip to masonry with dampproofing.

D. Where dampproofing of cavity walls adjoins other dampproofing or air barrier or weather barrier materials, coordinate with adjacent material installer to provide continuous weatherproofing barrier and to avoid incompatible materials coming in contact with each other. Take care not to apply or spill dampproofing on surfaces to receive incompatible weatherization membranes.

3.04 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete and Masonry Backup for Veneer Assemblies: Apply primer as recommended by manufacturer for substrates indicated, and one brush or spray coat at not less than 1 gal./100 sq. ft.

3.05 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.
   1. Install protection course within 24 hours of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.06 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 11 13

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide all building insulation as shown on the drawings and as herein specified.

B. Related Sections include the following:
   1. Division 04 Section - Unit Masonry Assemblies, for loose fill insulation in CMU cells.
   2. Division 06 Section – Wood Framing, for coordination with framing for packing cavities with Batt insulation.
   3. Division 06 Section - Sheathing.
   4. Division 07 Section - Sprayed Foam Thermal Insulation (Alternate).
   5. Division 07 Section - Air Barriers.
   6. Division 09 Section - Gypsum Board Assemblies.
   7. Division 09 Section - Acoustic Insulation.
   8. Division 21 and 23 Sections, for piping and mechanical ductwork insulation.

1.03 QUALITY ASSURANCE

A. Design Criteria:
   1. Thermal Resistance: R-Value designations indicated in accordance with ASTM C-518 is the thermal resistance of the insulation only.
   2. Fire Resistance: Material shall have a Class B fire rating less than 75 as tested by ASTM E-84.

B. Paper faced batt insulation shall not be used. Foil-faced insulation shall not be used except as specifically prescribed herein.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original packages, clearly marked with brand name, type and R-Value.

B. Store materials in area protected from weather, moisture and damage, remove any damaged materials from the site.

1.05 SUBMITTALS

A. Samples of materials and complete product literature (with documented R-Values) submitted for approval to the Architect prior to ordering materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with project requirements, Manufacturer’s offering Products which may be incorporated into the work include the following:
   1. CertainTeed Corporation, Valley Forge, PA. (215) 341-7000.

2. Owens-Corning Fiberglass Corporation, Toledo, OH. (419) 248-8000.
3. Schuller International, Insulation Division, Denver, CO. (800) 654-3103.
4. Johns Manville, Denver, CO.
5. Knauf Insulation, Shelbyville, IN.
6. Dow Chemical Company, Midland, MI.
7. ROXUL, Inc., Milton, Ontario

B. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.02 MATERIALS

A. Glass Fiber Batt Insulation: Unfaced with flame spread of 25 minutes in compliance with ASTM C665, Type III, Class A and ASTM 136.
   1. Provide at 2 x 6 stud construction in exterior walls and between conditioned and unconditioned spaces, unless otherwise noted: Nominal 5-1/2" thick batt insulation with an R-value of 21.
   2. Provide at 2 x 4 stud construction in walls and between conditioned and tempered spaces, unless otherwise noted: Nominal 3-1/2" thick batt insulation with an R-value of 13.

2.03 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates. Adhesive shall be compatible with air barrier membrane.

B. Provide insulation fasteners as recommended by manufacturer for substrates and conditions indicated.

C. Insulation Netting: For batt insulation below roof deck, provide insulation netting equal to ADO “1 x 2” Economy Mesh.

PART 3 - EXECUTION

3.01 INSPECTION AND COORDINATION

A. Examine areas receiving insulation work to insure work of preceding trades is completed. Check surfaces to see that they are uniform in place, free from mortar droppings, grease, oil or other debris which would affect proper insulation. Application constitutes acceptance of substrate conditions.

B. Coordinate marking centerline of studs on exterior face of continuous insulation as required for insulation installation and for subsequent fastener installation by other trades.

3.02 GENERAL INSTALLATION

A. Prepare surfaces using methods recommended by manufacturer for achieving the best result for the substrate under the project conditions.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Insulation installed in accordance with current printed recommendations of insulation manufacturer as specified.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

F. Install batt insulation without visible voids, gaps or separations. Place insulation in Cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members. Cut and trim insulation neatly to fit spaces without laps, bulges or folds. Use batts free of rips and tears.

G. Fit insulation tight within spaces and tight to and behind mechanical and electrical wiring.

H. Install insulation netting below roof insulation, to prevent future sagging. Do not compress insulation more than 1/2 inch when installing netting. Fasten to top chord of roof trusses.

3.03 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Install batt insulation in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
   4. Fill roof expansion joints with batt insulation to equal or greater R-value of insulation at roof surface.

3.04 FIELD QUALITY CONTROL

A. Comply with requirements of Authorities having jurisdiction for inspection of installation of insulation, and with requirements of commissioning agent. Notify respective parties and schedule required inspections prior to closing walls or cavities containing thermal insulation.

3.05 CLEANING

A. Comply with requirements of Division 01, Section "Construction Waste Management".

END OF SECTION 07 21 00

SECTION 07 26 00 - VAPOR BARRIER MEMBRANE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes:
   1. Vapor barrier film beneath slabs on grade and slabs on void forms.

B. Related Sections:
   1. Division 03 Section - Cast-in-Place Concrete.
   2. Division 31 Section - Earthwork.

1.03 COORDINATION

A. Coordinate installation with scheduled concrete pours to avoid delays. Make provision for installation of work by other trades.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM E 1745- 11 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
   2. ASTM E 154- 08 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
   3. ASTM F 1249-06 (2011) Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
   4. ASTM D 882-10 Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
   5. ASTM D 1709-09 Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
   6. ASTM E 1643- 11 Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

B. American Concrete Institute (ACI):
   1. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.

1.05 SUBMITTALS

A. Division 01 Section - Submittal Procedures: Procedures for submittals.

B. Quality Control / Assurance:
   1. Summary of test results as per paragraph 8.3 of ASTM E 1745.
   2. Manufacturer's literature.
   3. Manufacturer's installation instructions for placement, seaming and penetration repair.

C. Provide 12" x 12" samples of vapor barrier material and samples of tape for joints.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturer's offering Products which may be incorporated in the Work include the following:
   1. Basis of Design: Stego Industries LLC (281) 367-0040 www.stegoindustries.com.
   2. Raven Industries (800) 635-3456 www.ravenefd.com.
   3. Reef Industries (713) 507-4250 www.reefindustries.com.

B. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Not Permitted

2.02 MATERIALS

A. Membrane Film:
   1. Qualities:
      a. Maintain a permeance of less than 0.01 Perms [grains/(ft^2 · hr · inHg)], as tested in accordance ASTM E-154, with mandatory conditioning tests, per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
      b. Strength: ASTM E 1745 Class A.
      c. Thickness: 15mils minimum, in accordance with ACI 302.2R-06.
      d. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1.
   2. Available products:
      a. Basis of Design: Stego Wrap Vapor Barrier (15 mil) by Stego Industries.
      b. Vapor Block (15 mil) by Raven Industries.
      c. VaporGuard (15 mil) by Reef Industries.
      d. No Substitutions.

B. Accessories:
   1. Seams Tape: Stego Tape by Stego Industries LLC, or membrane manufacturer's standard tape for applications indicated.
   2. Penetration Repair: Stego Mastic and Stego Tape by Stego Industries LLC, or membrane manufacturer's standard product for applications indicated.
   3. Perimeter / Edge Seal: Crete Claw, Stego Tack Tape and Stego Term Bar by Stego Industries LLC, or membrane manufacturer's standard product for applications indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Do not proceed until fill is level and without voids, and plumbing and electrical rough-ins are complete.

3.02 INSTALLATION - GENERAL

A. Install Vapor Barrier in accordance with ASTM E 1643-11:
   1. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
   2. Extend vapor barrier over footings and grade beams to a distance acceptable to the structural engineer or stop at impediments such as dowels and waterstops.

3. Seal vapor barrier to slab perimeter/edge using Stego Crete Claw and remove dirt, debris, and mud from Crete Claw prior to concrete placement.
4. Alternate: Seal vapor barrier to footing/grade beam with double sided tape, termination bar, or both.
5. Overlap joints 6 inches and seal with manufacturer's tape.
6. Apply tape/Crete Claw to a clean and dry vapor barrier.
7. Seal all penetrations (including pipes) per manufacturer's instructions.
8. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.
9. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all sides with tape.

B. Vapor Barrier over void boxes:
1. Cartons for slabs shall have protective cover board with Stego 15 mil and Stego Crete-Claw Tape.
2. Stego Crete-Claw Tape Instructions: Overlap seams a minimum of 6 inches. Seal all seams in Stego Wrap using Crete-Claw Tape.
3. Install Crete-Claw Tape on the entire perimeter of the Stego Wrap Installation.
4. Install additional Crete-Claw Tape if required.

3.03 PROTECTION

A. Protect completed membrane from damage. Prior to pouring concrete, inspect membrane for punctures or damage and repair as required.
1. At crawl space applications, inspect membrane for damage prior to substantial completion. Repair damaged areas per membrane manufacturer's instructions.

END OF SECTION 07 26 00

SECTION 07 27 13 - MODIFIED BITUMINOUS SHEET AIR BARRIERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work of this section includes, but is not limited to, the following:
   1. Materials and installation methods for self-adhering, vapor-retarding, modified bituminous sheet air barriers located in the non-accessible part of the wall applied to the following surfaces:
      a. Exterior face of exterior sheathing in locations above adjacent roof surfaces and as shown in Drawings.
      b. Flashing membranes for sealing adjacent air and weather barrier system(s), as required to provide a continuous weather-tight installation.

B. Related Sections include the following:
   1. Division 04 Section – Stone Masonry.
   2. Division 06 Section - Rough Carpentry.
   3. Division 06 Section - Wood Framing.
   4. Division 06 Section - Sheathing.
   5. Division 07 Section - Flashing and Sheet Metal for sheet metal flashings.
   6. Division 07 Section - Joint Sealants for joint-sealant materials and installation.

1.03 DEFINITIONS

A. ABAA: Air Barrier Association of America.

B. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.04 PERFORMANCE REQUIREMENTS

A. General: Provide an air and vapor barrier system to perform as a continuous vapor-retarding air barrier, and to act as a liquid water drainage plane flashed to discharge any incidental condensation or water penetration. Air barriers shall be capable of accommodating substrate movement and sealing of substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air Barrier Assembly Air Leakage: Not to exceed 0.004 cfm/ft2 under a pressure differential of 0.3 in. water. (1.57 psf.) (equal to 0.02L/s/m2 @ 75 Pa.).

C. Temperature: Provide “High Temperature” (HT) rated product.

1.05 ACTION SUBMITTALS

A. Product Data: Submit manufacturer’s product data, installation instructions, use limitations and substrate preparation recommendations for each applicable substrate.

B. Shop drawings showing locations and extent of air and vapor barrier system including details for terminations flashings, penetrations, window and door openings and treatment of substrate joints and cracks.

1. Include details of interfaces with other materials that form part of the complete building air barrier or weather barrier system.

C. Written documentation demonstrating installers' qualifications under the "Quality Assurance" article including reference projects of a similar scope.

D. Samples: Submit representative samples of the following for approval:
   1. Self-Adhered Air Barrier Membrane
   2. Self-Adhered Transition Membrane

1.06 INFORMATIONAL SUBMITTALS

A. Written documentation demonstrating installers' qualifications under the "Quality Assurance" article including reference projects of a similar scope.

B. Product Certificates: For air barriers, certifying compatibility of air barrier and accessory materials with Project materials that connect to or that come in contact with air barrier; signed by product manufacturer.

C. Warranty: Submit a sample Warranty identifying the terms and conditions.

1.07 QUALITY ASSURANCE

A. Manufacturer: Air and vapor barrier systems shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of waterproofing and air barrier products. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.

B. Installer: The installer shall demonstrate qualifications to perform the work of this Section by submitting the following:
   1. List of at least three (3) projects contracted within the past five (5) years of similar scope and complexity to this project carried out by the firm and site supervisor.
   2. Installer must show evidence of adequate equipment and trained field personnel to successfully complete the project in a timely manner.

C. Materials: Self-adhered air and vapor barrier material shall be 40 mil (.004 in) comprising 36 mil (.0036 in.) rubberized asphalt integrally bonded to 4 mil (.0004 in.) cross-laminated polyethylene film, rated for high temperature installation (HT). For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.

D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include but not be limited to the following:
   1. Review of submittals.
   2. Review of surface preparation, minimum curing period and installation procedures.
   3. Review of special details and flashings, including connection details with other air and weather barrier systems.
   4. Sequence of construction, responsibilities and schedule for subsequent operations.
   5. Review of mock-up requirements.
   6. Review of inspection, testing, protection and repair procedures.

E. Mock-up:
   1. Prior to installation of the air and vapor barrier system a field-constructed mock-up shall be provided under the provisions of Division 1 Section - Submittals, Product Data,

Samples and Mock-ups, to verify details & tie-ins, and to demonstrate the required quality of materials and installation.

2. Construct a typical exterior wall section, as indicated in drawings, incorporating back-up wall, cladding, window and doorframe and sill, insulation, flashing and any other critical junction (foundation, inside and outside corners, etc).
3. Allow 24 hours for inspection and testing of mock-up before proceeding with air and vapor barrier work.

F. Inspection and Testing: Cooperate and coordinate with the Owner's inspection and testing agency. Do not cover any installed air and vapor barrier membrane until it has been inspected, tested and approved.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

B. Do not double-stack pallets of membrane components. Provide cover on top and all sides, allowing for adequate ventilation.

C. Protect membrane components from freezing and extreme heat.

D. Sequence deliveries to avoid delays, but minimize on-site storage.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist. Barrier must be covered with exterior material within 30 days of installation or be replaced.

B. Coordinate air barrier installation to avoid excessive exposure to ultraviolet rays and other damage. Barrier must be covered with exterior material or protected in accordance with Manufacturer's requirements within Manufacturer's exposure time limitations or be replaced.

PART 2 - PRODUCTS

2.01 SELF-ADHERED AIR BARRIER MEMBRANE

A. Description: Min. 1 mm (.040 in) thick membrane comprised of 0.9 mm (0.036 in) of self-adhesive rubberized asphalt integrally bonded to 0.1 mm (.004 in) of cross-laminated, high-density polyethylene film. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Minimum Performance Requirements:

Property	Test Method	Typical Value
Thickness	ASTM D 3767 Method A	1.0 mm (0.040 in.) nominal
Air Permeance at 75Pa (0.3 in. water) Differential Pressure	ASTM E 2178	<0.001 L/(s.m^2) (<0.0002 cfm/ft^2)
Assembly Air Permeance at 75Pa (0.3 in. water) Differential Pressure	ASTM E 2357	<0.004 L/s*m^2 (<0.0008 cfm/ft^2)
Water Vapor Permeance	ASTM E 96, Method B	Less than 2.9 ng/Pa.s.m^2 (0.05 Perms)
Water Absorption: -	ASTM D 570	Max. 0.1% by weight

Puncture Resistance	ASTM E 154	178 N (40 lbs.)
Tear Resistance	Initiation - ASTM D 1004 Propagation - ASTM D1938	Min. 58 N (7.0 lbs.) M.D. Min. 40 N (4.0 lbs.) M.D.
Lap Adhesion at -4°C (25°F)	ASTM D 1876	880 N/m (5.0 lbs./in.) of width
Low Temperature Flexibility	ASTM D 1970	Unaffected to -43°C (-45°F)
Tensile Strength	ASTM D 412, Die C Modified	Min. 2.7 MPa (400 psi)
Elongation, Ultimate Failure of Rubberized Asphalt	ASTM D 412 - Die C	Min. 200%

C. Air barrier applied to wall at all walls above adjacent lower roofs and where indicated: Basis of Design Product: Grace Construction Products: Perm-A-Barrier® High Temperature (HT) Wall Membrane. Subject to compliance with requirements, provide the named product, or approved equal system by another manufacturer.
   1. For In-Service Temperatures up to at least 180 degree F, including accessories.

D. Substitutions: Permitted, with proof of equal performance characteristics. Submit comparison data for basis of design and proposed alternate products, and manufacturer's certification of equal performance characteristics.

2.02 TRANSITION MEMBRANE

A. Description: Min. 1 mm (.040 in / 40 mil) thick membrane comprised of 0.9 mm (0.036 in) of self-adhesive rubberized asphalt integrally bonded to 0.1 mm (.004 in) of cross-laminated, high-density polyethylene film. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Performance Requirements:
   1. Water Vapor Transmission: ASTM E 96, Method B: 2.9 ng/m2sPa (0.05 perms) max.
   2. Air Permeance at 75Pa (0.3 in. water) pressure difference: 0.0006 L/(s.m^2) (0.00012 cfm/ft^2) max.
   3. Puncture Resistance: ASTM E 154: 178 N (40 lbs.) min.
   4. Lap Adhesion at -4°C (25°F), ASTM D 1876: 880 N/m (5.0 lbs./in.) of width min.
   5. Low Temperature Flexibility, ASTM D 1970: Unaffected to -43°C (-45°F).
   6. Tensile Strength, ASTM D 412, Die C Modified: min. 2.7 MPa (400 psi)
   7. Elongation, Ultimate Failure of Rubberized Asphalt, ASTM D 412 Die C: min. 200%

C. Materials:
   1. Perm-A-Barrier High Temperature Detail Membrane manufactured by Grace Construction Products, or approved equal by other approved air barrier manufacturer.
      a. In-Service Temperature Range: Meet or exceed the requirements for self-adhered membrane.

2.03 AIR & VAPOR BARRIER ACCESSORIES

A. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier membrane. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Termination Bar: Air barrier manufacturer's recommended termination bar for applications indicated.

C. Joint Reinforcing Strip: Air barrier manufacturer's glass-fiber-mesh tape.

D. Sprayed Polyurethane Foam Sealant: 1- or 2-component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft density; flame spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

E. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section - Joint Sealants.

F. Primer: Water-based primer which imparts an aggressive, high tack finish on the treated substrate
   1. Flash Point: No flash to boiling point
   2. Solvent Type: Water
   3. VOC Content: Not to exceed 10 g/l
   4. Application Temperature: -4°C (25°F) and above
   5. Freezing point (as packaged): -7°C (21°F)
   6. Product: Perm-A-Barrier WB Primer manufactured by Grace Construction Products, or equal by other approved air barrier manufacturer.

G. Sealant: Two-part, elastomeric, trowel grade material designed for use with self-adhered membranes and tapes. 10 g/l max. VOC Content.
   1. Product: Bituthene® Liquid Membrane manufactured by Grace Construction Products, or equal by other approved air barrier manufacturer.

H. Optional Primers:
   1. Description: High tack water based primer. 10 g/l max. VOC content.
      a. Product: Perm-A-Barrier Liquid Part B manufactured by Grace Construction Products, or equal by other approved air barrier manufacturer.
   2. Description: High tack low VOC solvent based primer. <200 g/l max. VOC content.
      a. Product: Bituthene Primer B2 LVC manufactured by Grace Construction Products, or equal by other approved air barrier manufacturer.
   3. Description: High tack solvent based primer. 440 g/l max. VOC content.
      a. Product: Bituthene Primer B2 manufactured by Grace Construction Products, or equal by other approved air barrier manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
   1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Fill and treat joints according to membrane manufacturer's recommendations for each substrate indicated, and per manufacturer's recommendations to prevent excessive outward building pressures from being exerted on the membrane.
2. Install modified bituminous strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
3. Prime substrates according to membrane manufacturer's requirements for each substrate material indicated.

D. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping modified bituminous strips.

E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

F. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

G. Exterior sheathing panels: Ensure that the boards are sufficiently stabilized with corners and edges fastened with appropriate screws in accordance with exterior sheathing manufacturer's written instructions.

3.03 INSTALLATION

A. Refer to membrane manufacturer’s literature for recommendations on installation

B. Apply air barrier membrane to achieve a continuous air barrier according to air barrier manufacturer's written instructions.

C. Application of Self-Adhered Air Barrier Membrane
1. **Allow Architect to inspect installation prior to enclosing/covering.**
2. Install air & vapor barrier to dry surfaces at air and surface temperatures of 40°F and above in accordance with manufacturer's recommendations, at locations indicated on Construction Documents.
3. Prime substrate to receive air barrier membrane as required per manufacturers written instructions.
4. Precut pieces of air & vapor barrier into easily handled lengths.
5. Remove silicone-coated release paper and position membrane carefully before placing length horizontally against the surface.
6. Begin installation at the base of the wall placing top edge of membrane immediately below any masonry reinforcement or ties protruding from substrate.
7. When properly positioned, place against surface by pressing firmly into place. Roll membrane with extension-handled countertop roller immediately after placement.
8. Overlap horizontally adjacent pieces 50 mm (2 in.) and roll seams.
9. Subsequent sheets of membrane applied above shall be positioned immediately below masonry reinforcement or ties. Bottom edge shall be slit to fit around reinforcing wires or ties, and membrane shall overlap the membrane sheet below by 50 mm (2 in.). Roll firmly into place.
10. Seal around masonry reinforcing or ties and all penetrations with termination mastic.
11. Continue the membrane into all openings in the wall, such as doors, windows, etc., and terminate at points that will prevent visibility from interior.
12. Coordinate the installation of air & vapor barrier with roof installer to ensure continuity of membrane with rooftop air & vapor membrane.
13. At end of each working day seal top edge of air & vapor barrier to substrate with termination mastic.

14. Do not allow the rubberized asphalt surface of the air & vapor barrier membrane to come in contact with polysulfide sealants, creosote, uncured coal tar products or EPDM.
15. Do not expose air & vapor barrier membrane to sunlight for more than thirty days prior to enclosure.
16. Inspect installation prior to enclosing and repair punctures, damaged areas and inadequately lapped seams with a patch of the membrane sized to extend 150 mm (6 in.) in all directions from the perimeter of the affected area.

D. Application of Transition Membrane
1. Prime substrate to receive transition membrane as required per manufacturers written instructions.
2. Apply transition membrane with a minimum overlap of 75mm (3 in.) onto each surface at all beams, columns and joints as indicated in detail drawings.
3. Tie in to window and door frames, spandrel panels, roof and floor intersections and changes in substrate.
4. Use pre-cut, easily handled lengths for each location.
5. Remove silicone-coated release paper and position membrane flashing carefully before placing it against the surface.
6. When properly positioned, place against surface by pressing firmly into place by hand roller.
7. Overlap adjacent pieces 50 mm (2 in.) and roll all seams with a hand roller.
8. Seal top edge of flashing with termination mastic.
9. When transition flashing is pre-installed prior to application of Fluid Applied Membrane, apply transition flashing as above. Spray or trowel a continuous uniform film of Fluid Membrane at min. 60 mils (1.5 mm or .060 in.) dry film thickness using multiple, overlapping passes, with a minimum overlap of 75 mm (3 in.) onto transition flashing. For sill condition, spray or trowel Fluid Membrane onto pre-installed sill flashing and onto horizontal section of sill.

E. Termination Bars: Install termination bars as applicable according to manufacturer's recommendations. Install termination bars where recommended by the manufacturer, and where specifically detailed in the Drawings.

3.04 PROTECTION AND CLEANING

A. Remove any masking materials after installation. Clean any stains on materials that would be exposed in the completed work using procedures as recommended by the manufacturer of affected construction.

B. Protect the air barrier from damage and wear during remainder of construction period. Repair damage according to manufacturer's instructions.

C. Wall Membranes are not suitable for permanent exposure and should be protected from the effects of sunlight. Maximum sun exposure is limited to 30 days. Schedule work to ensure that the Wall Membrane system is covered as soon as possible after installation. Protect the Wall Membrane system from damage during subsequent operations. If the Wall Membrane system cannot be covered within 30 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

END OF SECTION 07 27 13

SECTION 07 27 19 - PLASTIC FILM AIR BARRIER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Air and moisture barrier building wrap, at stone veneer cavity wall and where detailed in drawings.

B. Related Sections include the following:
   1. Division 04 Sections, for coordination of membrane flashing tape type to be used at masonry ties and anchors.
   2. Division 06 Section – Wood Framing.
   3. Division 06 Section – Sheathing
   4. Division 07 Section - Bituminous Damp-Proofing.
   5. Division 07, other “Air Barrier” or “Weather Barrier” Sections, for coordination of materials and details at junctures of different weatherization systems.
   6. Division 07 Section - Self Adhering Sheet Damp-Proofing.

1.03 PERFORMANCE REQUIREMENTS

A. ASTM E 1677, Type I air retarder; with flame-spread and smoke-developed indexes of less than 25 and 450 respectively, when tested in accordance with ASTM E 84.

B. ASTM D882; Test method for tensile properties of thin plastic sheeting.

C. Water Vapor Permeance: Not less than 350 g/sq. m in 24 hours (20 perms) per ASTM E 96.

1.04 SUBMITTALS

A. Product Data for each type of product specified.
   1. Submit manufacturer’s standard product literature.

B. Quality Assurance/Control Submittals:
   1. Certificates: Manufacturer's certificate or test data that Products meet or exceed specified requirements.
   2. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.
   3. Submit manufacturer’s written installation instructions.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
   2. Installer: Company specializing in performing the Work of this Section with minimum 5 years documented experience.

B. Source Limitations: Provide all commercial grade materials. Provide all materials from a single manufacturer, or as recommended by the air barrier manufacturer for use with their system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.

B. Store and protect materials during construction keeping dry and away from open flame or sparks in compliance with manufacturer's recommendations.

1.07 SCHEDULING AND COORDINATION

A. Review requirements for sequencing of installation of weather barrier assembly with installation of windows, doors, louvers and flashings to provide a weather-tight barrier assembly.

B. Schedule installation of air-barrier materials and exterior cladding within nine months of weather barrier assembly installation, or manufacturer's requirement, whichever is more stringent.

C. Coordinate with other air barrier and waterproofing systems specified. Provide membrane flashing and other joint materials as required for compatible joint conditions with adjacent systems, and to provide a continuous weatherization system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include, but are not limited to the following:
   1. DuPont Tyvek Drain Wrap, for use behind wood or cement siding cladding systems.
   2. DuPont Tyvek Commercial Wrap, for use behind brick-veneer masonry, metal, stone, or synthetic stone veneer cladding systems.

2.02 ACCESSORIES

A. Seam Tape: Minimum 3 inch wide, pressure sensitive tape with approved adhesive, as recommended by the air-moisture barrier manufacturer for commercial applications.

B. Building Wrap Fasteners: Plastic disk fastener-caps with screws, of type and spacing as approved by weather barrier manufacturer for application to substrate. No staples allowed.

C. Building Wrap Sealants: Acrylic or polyurethane sealant as approved by air-barrier manufacturer for applications indicated. Refer to Division 07 Section - Sealants for compliance with exterior-grade sealants.

D. Adhesives: Use only adhesives recommended by weather barrier manufacturer.

E. Primers: Provide primer to assist in adhesion between substrate and flashing, as recommended by flashing manufacturer.

F. Membrane Flashings:
   1. Provide self adhering membrane flashings as recommended by air-barrier manufacturer for applicable flashing conditions, opening types, and masonry veneer ties and anchors.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required by manufacturer, dry, free of loose materials, and ready to receive air-barrier installation.

B. By beginning installation, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 PREPARATION

A. Remove existing air and weather barriers, flashings, carrier or protective films and similar materials that would impede adhesion from substrates indicated to receive elasticized flexible flashing tape. Clean surfaces thoroughly prior to installation in compliance with air-barrier manufacturer's recommendations.

3.03 INSTALLATION

A. Install weather barrier over exterior face of exterior wall substrate in accordance with manufacturer recommendations.

B. Install air barrier sheets and assembly materials to form a seal with adjacent construction and to maintain a continuous air barrier.

C. Connect and seal building sheet air barrier membrane continuously to exterior window and door openings, construction transitions and other penetrations in exterior wall openings using self-adhering flexible flashing.
   1. Apply self-adhering flexible flashing so that a minimum of 3 inches of coverage is achieved over adjacent substrates.

D. Openings and Penetrations: Provide straight and flexible flashings for openings as required to provide weather-tight barrier. Install lapped components to direct water to exterior of building.
   1. Install weather barrier in a horizontal manner starting at the lower portion of the wall surface with subsequent layers installed in a shingling manner to overlap lower layers. Maintain weather barrier plumb and level.

E. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten all fish-mouths and blisters. Patch with air barrier sheet extending 6 inches beyond repaired areas in all directions shingled in proper lapped condition to direct water to exterior cavity.

F. Correct deficiencies in or remove air barrier membrane that does not comply with requirements; repair substrates and reapply air barrier components.

G. Install weather barrier prior to installation of windows and doors.

H. Start weather barrier installation at a building corner, leaving 6-12 inches of weather barrier extended beyond corner to overlap.

I. Sill Plate Interface: Extend lower edge of weather barrier over sill plate interface 3-6 inches. Secure to foundation with elastomeric sealant as recommended by weather barrier manufacturer.

J. Window and Door Openings: Extend weather barrier completely over openings.

K. Overlap weather barrier
   1. Exterior corners: minimum 12 inches.
   2. Seams: minimum 6 inches.

L. Weather Barrier Attachment:

1. Attach weather barrier to studs through exterior sheathing. Secure using weather barrier manufacturer recommended fasteners, space 12 -18 inches vertically on center along stud line, and 24 inch on center, maximum horizontally.

M. Apply membrane flashing to weather barrier membrane as recommended by manufacturer prior to the installation of cladding anchors.

N. Seal face of wall to storefront jamb with flashing membrane. Turn to exterior and lap 3".

3.04 SEAMING

A. Seal seams of weather barrier with seam tape at all vertical and horizontal overlapping seams.

B. Seal any tears or cuts.

3.05 OPENING PREPARATION (FOR USE WITH NON-FLANGED WINDOWS)

A. Flush cut weather barrier at edge of sheathing around full perimeter of opening.

B. Cut a head flap at 45-degree angle in the weather barrier at window head to expose 8 inches of sheathing. Temporarily secure weather barrier flap away from sheathing with tape.

3.06 FLASHING (FOR USE WITH NON-FLANGED WINDOWS)

A. Cut sill flashing membrane a minimum of 12 inches longer than width of sill rough opening. Apply primer as required by manufacturer.

B. Cover horizontal sill by aligning sill flashing membrane edge with inside edge of sill. Adhere to rough opening across sill and up jambs a minimum of 6 inches. Secure flashing tightly into corners by working in along the sill before adhering up the jambs.

C. Fan sill flashing membrane at bottom corners onto face of wall. Firmly press in place. Mechanically fasten fanned edges.

D. Apply 9-inch wide strips of flashing membrane at jambs. Align flashing membrane with interior edge of jamb framing. Start flashing membrane at head of opening and lap sill flashing membrane down to the sill.

E. Spray-apply primer to top 6 inches of jambs and exposed sheathing.

F. Install sill flashing membrane at opening head using same installation procedures used at sill. Overlap jamb flashing membrane a minimum of 2 inches.

G. Coordinate flashing with window, door, and louver installation.

H. On exterior, install backer-rod in joint between window door or louver frame and flashed rough framing. Apply sealant at jambs and head, leaving sill unsealed. Apply sealants in accordance with sealant manufacturer's instructions and ASTM C 1193.

I. Position weather barrier head flap across head flashing. Adhere using flashing membrane or type as recommended by weather barrier manufacturer over the 45-degree seams.

J. Tape top of window in accordance with weather barrier manufacturer's recommendations.

K. Seal interior side of opening as required.

L. Where jambs in cavity wall construction are detailed with stainless steel flashings, seal flashings to wall with self-adhering membrane flashings.

3.07 OPENING PREPARATION (FOR USE WITH FLANGED WINDOWS)

A. Cut weather barrier in a modified "I-cut" pattern., per manufacturer's recommendations and instructions.
   1. Cut weather barrier horizontally along the bottom of the header.
   2. Cut weather barrier vertically 2/3 of the way down from top center of window opening.
   3. Cut weather barrier diagonally from bottom of center vertical cut to the left and right corners of the opening.
   4. Fold side and bottom weather barrier flaps into window opening and fasten.

B. Cut a head flap at 45-degree angle in the weather barrier at window head to expose 8 inches of sheathing. Temporarily secure weather barrier flap away from sheathing with tape.

3.08 FLASHING (FOR USE WITH FLANGED WINDOWS)

A. Cut sill flashing membrane a minimum of 12 inches longer than width of sill rough opening.

B. Cover horizontal sill by aligning sill flashing membrane edge with inside edge of sill. Adhere to rough opening across sill and up jambs a minimum of 6 inches. Secure flashing tightly into corners by working in along the sill before adhering up the jambs.

C. Fan sill flashing membrane at bottom corners onto face of wall. Firmly press in place. Mechanically fasten fanned edges.

D. On exterior, apply continuous bead of sealant to wall or backside of window mounting flange across jambs and head. Do not apply sealant across sill.

E. Install window according to manufacturer's instructions.

F. Apply 4-inch wide strips of flashing membrane at jambs overlapping entire mounting flange. Extend jamb flashing 1-inch above top of rough opening and below bottom edge of sill flashing.

G. Apply 4-inch wide strip of flashing membrane at the window head flashing overlapping the mounting flange. Head flashing membrane should extend beyond outside edges of both jamb flashings.

H. Position weather barrier head flap across head flashing. Adhere using 4-inch wide flashing membrane over the 45-degree seams.

I. Tape head flap in accordance with manufacturer recommendations.

J. On interior, install backer rod in joint between frame of window and flashed rough framing. Apply sealant around entire window to create air seal. Apply sealant in accordance with sealant manufacturer's instructions and ASTM C 1193.

3.09 PROTECTION

A. Protect air barrier system from sparks, open flames and damage during application and remainder of construction period, according to manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed to these conditions for more than 180 days.

B. Protect air barrier from contact with solvents, coatings, mastic or sealants not approved by air barrier manufacturer

C. Inspect for damage just prior to installation of exterior finish materials and promptly repair damaged conditions.

END OF SECTION 07 27 19

SECTION 07 46 00 – SIDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Fiber-cement soffit and trims.

B. Related Sections:
   1. Division 06 Section "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
   2. Division 06 Section "Sheathing" for wall sheathing and weather-resistive barriers.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Initial Selection: For siding and soffit including related accessories.

C. Samples for Verification: For each type, color, texture, and pattern required.
   1. 12-inch- long-by-actual-width Sample of non-vented soffit.
   2. 12-inch- long-by-actual-width Samples of trim and accessories.

D. Qualification Data: For qualified siding Installer.

E. Product Certificates: For each type of siding and soffit, from manufacturer.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.

G. Research/Evaluation Reports: For each type of siding required, from the ICC.

H. Maintenance Data: For each type of siding and soffit and related accessories to include in maintenance manuals.

I. Warranty: Sample of special warranty.

1.04 QUALITY ASSURANCE

A. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.

B. Source Limitations: Obtain each type, color, texture, and pattern of siding [and] soffit, including related accessories, from single source from single manufacturer.

C. Preinstallation Conference: Conduct conference at Project site as required.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a dry, well-ventilated, weathertight place.

1.06 COORDINATION

A. Coordinate installation with flashings and other adjoining construction to ensure proper sequencing.

1.07 WARRANTY

A. Special Warranty: Standard form in which manufacturer agrees to repair or replace siding and soffit that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including cracking and deforming.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

B. Product Warranty: Limited product warranty against manufacturing defects.
   1. Allura Lap Siding, Soffit, and Plycem Trim for 50 years.

C. Finish Warranty: Limited product warranty against manufacturing finish defects.
   1. Colormax, including Stains, for 15 years from the date of purchase:
      a. Will remain washable with a mild detergent, soft sponge, and hose rinse.
      b. Will not peel, crack, flake, or yellow.
      c. Will not cause discoloration or stains due to chalking on back or other surfaces below coating.
      d. Will not erode to expose the surface of the Fiber Cement Siding.

D. Workmanship Warranty: Application limited warranty for 2 years.

1.08 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish full lengths of siding and soffit including related accessories, in a quantity equal to 2 percent of amount installed.

PART 2 - PRODUCTS

2.01 FIBER-CEMENT SOFFIT

A. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
   1. Manufacturers: Subject to compliance with requirements, provide the following:
      a. Fiber Reinforced Cementitious Soffit.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
      a. Allura USA, Fiber Cement, Traditional Ventilated Soffit panels.
      b. Alternate 6: Allura USA, Fiber Cement, Traditional Soffit panels.
      c. Allura USA, Fiber Cement Soffit Panels, non-vented at covered patio soffits.

B. Style: Traditional (wood grain) texture to match siding.
   1. Select from manufacturer's standard soffit board sizes as required to minimized waste:
      a. Typical Length: 12 feet.
      b. Available widths: 12 inches, 16 inches, 24 inches.
   2. Typical non-vented soffit panel size: 4 foot-by-8 foot

C. Ventilation: Provide perforated soffit, except at covered patios.

D. Factory Finish: Manufacturer's standard primer.

2.02 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
   1. Provide accessories made from same material as matching color and texture of adjacent siding unless otherwise indicated.

B. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated in drawings:
   1. Trim, Woodgrain texture.
      a. Trim - 4/4" x 4"

C. Colors for Decorative Accessories: As selected by Architect from manufacturer's full range of industry colors.

D. Flashing: Provide hot-dipped galvanized metal flashing complying with Division 07 Section "Sheet Metal Flashing and Trim" at window and door heads, and as indicated in drawings.

E. Fasteners:
   1. For fastening to wood, use siding nails of sufficient length to penetrate a minimum of 1 inch into substrate.
   2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch, or three screw-threads, into substrate.
   3. For fastening fiber cement, use hot-dip galvanized fasteners.

F. Soffit Molding: Provide H-molding at soffit panel butt-joints, and F-molding at soffit panel ends, where applicable. Minimum width and depth required for soffit panels specified.
   1. Manufacturers: Tamlyn or approved equal.
   2. Color: As approved by Architect

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of siding and soffit and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.03 INSTALLATION

A. General: Comply with siding and soffit manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
   1. Do not install damaged components.
   2. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

B. Install fiber-cement siding and soffit and related accessories.
   1. Install fasteners no more than 24 inches o.c.
   2. Wherever possible, install soffit panels in a symmetrical layout, or as indicated on drawings.
   3. Refer to manufacturer’s installation manual for installation requirements, flashing, and other accessories.

C. Install joint sealants as specified in Division 07 Section "Joint Sealants" and to produce a weathertight installation.

3.04 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 00

SECTION 07 54 00 - THERMOPLASTIC MEMBRANE ROOFING (PVC)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes:
   1. Fully adhered, PVC membrane roofing system.
   2. Roof Insulation.
   3. Prefabricated flashings, corners, parapets, stacks, vents, and related details.
   4. Fasteners, adhesives, and other accessories required for complete roof installation.
   5. Traffic protection.

B. Related Sections:
   1. Division 06 Section - Rough Carpentry for blocking, nailers, etc.
   2. Division 07 Section - Roof Specialties.
   3. Division 07 Section - Roof Accessories.

1.03 REFERENCES

A. UL: Underwriters Laboratories.
   1. Roofing Materials and System Directory: TGFU.R10128.

B. FMG: Factory Mutual Global.
   1. Factory Mutual Standard 4470 - Approved Standard for Class 1 Roof Covers.

C. ASTM: American Society of Testing and Materials.
   1. ASTM C 578-04a, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation, © 2004, ASTM International.
   2. ASTM C 1177/C1177M-04e1, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing, © 2004, ASTM International.
   3. ASTM C 1289-04, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board, © 2004, ASTM International.
   4. ASTM C 1396/C1396M-04, Standard Specification for Gypsum Board, © 2004, ASTM International.
   5. ASTM D 146-04, Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing, © 2004, ASTM International.
   6. ASTM D 570-98, Standard Test Method for Water Absorption of Plastics, © 1998, ASTM International.
   7. ASTM D 751-00e1, Standard Test Methods for Coated Fabrics, © 2000, ASTM International.
   8. ASTM D 828-97(2002), Standard Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus, © 2002, ASTM International.
   9. ASTM D1079-05, Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials, © 2005, ASTM International.
   10. ASTM D 1204-02, Standard Test Method for Linear Dimensional Changes of Non-Rigid Thermoplastic Sheeting or Film at Elevated Temperature, © 2002, ASTM International.
   11. ASTM D 2136-02, Standard Test Method for Coated Fabrics-Low-Temperature Bend Test, © 2002, ASTM International.

12. ASTM D3045-03, Standard Practice for Heat Aging of Plastics Without Load, © 2003, ASTM International.
13. ASTM D 4434-96, Standard Specification for Poly(Vinyl Chloride) Sheet Roofing, © 1996, ASTM International.
14. ASTM D 5602-98, Standard Test Method for Static Puncture Resistance of Roofing Membrane Specimens, © 1998, ASTM International.
15. ASTM D 5635-04, Standard Test Method for Dynamic Puncture Resistance of Roofing Membrane Specimens, © 2004, ASTM International.
16. ASTM E 108-04, Standard Test Methods for Fire Tests of Roof Coverings, © 2004, ASTM International.
17. ASTM E 119-00a, Standard Test Methods for Fire Tests of Building Construction and Materials, © 2000, ASTM International.
18. ASTM G 154-00, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials, © 2000, ASTM International.

1.04 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 and glossary of NRCA's The NRCA Roofing and Waterproofing Manual for definition of terms related to roofing work in this Section.

1.05 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Physical Properties: Roof product must meet the requirements of type III PVC sheet roofing as defined by ASTM D4434-96 and must meet or exceed the following physical properties.
   1. Thickness: 60 mil, nominal per ASTM D751.
   2. Breaking Strengths: >240 lbf. per ASTM D751, Grab Method.
   3. Elongation at Break: >30% per ASTM D751, Grab Method.
   4. Heat Aging per ASTM D3045: 176°F for 56 days. No sign of cracking, chipping or crazing. (per ASTM D4434).
   5. Factory Seam Strength: 75% of breaking strength per ASTM D751, Grab Method.
   6. Tearing Strength: >55 lbf. per ASTM D751, Procedure B.
   7. Low Temperature Bend (Flexibility): Pass -40°F per ASTM D2136.
   8. Accelerated Weathering: No cracking, checking, crazing, erosion or chalking after 20,000 hours per ASTM G154.
   9. Linear Dimensional Change: <0.5% per ASTM D1204 @176 ± 2°F for 6 hours.
   10. Water Absorption: < 3% per ASTM D570.
   11. Static Puncture Resistance: > 33 lbs. per ASTM D5602.
   12. Dynamic Puncture Resistance: > 20 ft-lbf per ASTM D5635.

D. Minimum UL Class A fire rating.

E. Testing Requirements: The roof system shall be tested in compliance with local code requirements and as follows:
   1. Wind Resistance: The roof system shall be tested in compliance with FM4474, and with UL 580 or UL 1897.
   2. Physical Weathering Properties: The system shall be tested to demonstrate physical integrity over the working life of the roof based upon 2,000 hours of exposure to

accelerated weathering tests conducted in accordance with ASTM G152, ASTM G154, or ASTM G155.

3. Impact Resistance: The system shall be tested to resist impact damage based on the results of tests conducted in accordance with ASTM D3746, ASTM D4272, CGSB 37-GP-52M, or the "Resistance to Foot Traffic Test" in Section 5.5 of FM 4470.
4. Fire Classification: The system shall be identified and listed for the fire class as required by local code by an approved testing agency, tested in compliance with ASTM E 108 or UL 790.

F. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
1. Fire/Windstorm Classification: Class 1A-90.
2. Hail Resistance: SH.

G. Current International Code Council Evaluation Services Report or Legacy Report showing compliance with the International Building Code.

H. Energy Performance: Provide roofing system with Solar Reflectance Index (SRI) not less than 83 initial, 64 3-year aged, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

1.06 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastener spacing and patterns for mechanically fastened membrane roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

C. Samples for verification: For the following products:
1. 4-inch x 6-inch sample of roofing membrane, of color specified.
2. Sample of roofing membrane with factory weld.
3. 4-inch x 6-inch sample of walkway pad.
4. Termination bar, fascia bar with cover, drip edge and gravel stop if to be used.
5. A Sample of each fastener type to be used for installing membrane, insulation/recover board, termination bar and edge details.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in Performance Requirements Article.

F. ASTM D4434-96 Certification: Supply test results from qualified testing agency that states that the roofing product meets the requirements for type III PVC sheet roofing as defined in ASTM D4434-96.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

H. Field quality-control reports.

I. Maintenance Data: Outlining leak reporting procedure, maintenance requirements, and emergency repair procedures.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is FM Approvals approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by FM Global and membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Source Limitations: Obtain components including roof insulation, fasteners for membrane roofing system as approved by membrane roofing manufacturer.

D. Preinstallation Roofing Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
   5. Review structural loading limitations of roof deck during and after roofing.
   6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
   7. Review governing regulations and requirements for insurance and certificates if applicable.
   8. Review temporary protection requirements for roofing system during and after installation.
   9. Review roof observation and repair procedures after roofing installation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.09 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Contractor Warranty: The contractor shall warrant the roof application with respect to workmanship and proper application for two (2) years from the date of favorable inspection by the roof membrane manufacturer. Should any leaks covered under the warranty occur during this period, corrective action will be taken by the contractor to repair the roof to the satisfaction of the owner and the roof membrane manufacturer. All corrective work will be done at no cost to the owner or the roof membrane manufacturer.

B. Manufacturer Warranty: Must be no-dollar limit type and provide for completion of repairs, replacement of membrane or total replacement of the roofing system at the then-current material and labor prices throughout the life of the warranty. In addition the warranty must meet the following criteria:
   1. Warranty Period: 20 years from date of Substantial Completion.
   2. No exclusions for damage caused by water ponding or biological growth, or for incidental or consequential damages.
   3. Issued direct from and serviced by the roof membrane manufacturer.
   4. Transferable for the full term of the warranty.
   5. No additional charge for the warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Johns Manville.
   2. Duro-Last.
   3. Sarnafil Inc.
   4. GAF Materials Corporation.
   5. Carlisle Roofing.

2.02 PVC ROOFING MEMBRANE

A. PVC Sheet: ASTM D4434, Type III, fabric reinforced, as follows:
   1. Product: Subject to compliance with requirements, provide PVC roofing membrane that meets or exceeds the requirements stated under the section titled Performance Requirements.
   2. Thickness: 60 mils, +/- 2 mils.
   3. UL Class: A
   4. Exposed Face Color: White.
   5. Fully Adhered.

2.03 AUXILIARY MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet membrane.

C. Prefabricated Flashing: Prefabricated flashings for pipes, curbs, inside and outside corners of same material, type, reinforcement, and color as PVC sheet membrane.

D. Sealants and Adhesives: Caulk, pourable sealant, mastic and adhesives must be supplied by the roof membrane manufacturer.

E. Slip Sheet and Cover Boards: Slip sheet or cover boards, of type required by the roof membrane manufacturer for the application.

F. Termination Bars: Standard rigid exterior vinyl bar, 1.5-inch wide with slotted holes 6-inch on center must be manufactured by the roof membrane manufacturer.

G. Edge Detail: Fascia bar and cover, prefabricated Drip Edge, prefabricated Gravel Stop and 2-Piece Compression Metal Edge must be manufactured by the roof membrane manufacturer in custom shapes and sizes as shown in drawings.

H. Vinyl Coated Metal: 24 gauge, hot-dipped galvanized, grade 90 metal with a minimum of 17 mil of manufacturers membrane laminated to one side.

I. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and supplied by the roof membrane manufacturer.

J. Two-Way Vents: Provided by the roof membrane manufacturer. Must install a minimum of 1 vent per each 1000 square-feet.

2.04 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by PVC membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses and LTTR R-values indicated and that produce FM Approvals-approved roof insulation.
   1. Insulation Attachment: Adhered and/or Mechanically Fastened as required to achieve uplift resistance indicated.

B. Isocyanurate Rigid Foam Roof Insulation: ASTM C1289, Type II, Class 1, Grade 1. Panels shall have a nominal thickness of 4-1/2" to achieve an Long Term aged Thermal Resistance R-25 value per ASTM C1289-13e1.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.05 ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

C. Roof Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
   1. Product: Subject to compliance with requirements, provide Dens-Deck® Prime by Georgia-Pacific Corporation.

2.06 WALKWAYS

A. Flexible Walkways: Provide non-skid, maintenance-free walkway pads in areas of heavy foot traffic, around roof hatches, at top and bottom of roof access ladders, on all sides of mechanical equipment, under pipe pedestals and similar rooftop supports, and at other

locations as indicated in the Drawings. Walkway pads must be manufactured by the roof membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thickness of insulation.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to the roof membrane manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.03 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
   1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation and adhere to approved substrate as follows:
   1. Adhere insulation with product approved by the roof membrane manufacturer. Follow the roof membrane manufacturer's application guidelines.
   2. Set each layer of insulation in insulation adhesive. Follow adhesive manufacturer's application guidelines.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Stagger joints from joints in insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.
   1. Fasten according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
   2. Fasteners and plates must be supplied by the roof membrane manufacturer.

3.04 ADHERED ROOFING MEMBRANE INSTALLATION

A. Install prefabricated roofing sections over area to receive roofing according to the roof membrane manufacturer's written instructions.
   1. Confirm that substrate is approved by the roof membrane manufacturer to receive adhered membrane.
   2. If membrane is to be adhered to a substrate board or an insulation board, confirm that the board is attached per the roof membrane manufacturer's specification.
   3. Apply adhesive within the temperature range and at application rates specified by the roof membrane manufacturer.

B. Accurately align each prefabricated roofing section in order to maintain overlaps of the minimum dimensions required by the roof membrane manufacturer.

C. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to the roof membrane manufacturer's written instructions to ensure a watertight seam installation.
   1. Hot-air welded seams must be a minimum of 1-1/2 inch wide.
   2. After seam has cooled make a hands and knees inspection with a probe. Repair any deficiencies found immediately.

D. Mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

E. Penetrations: Utilize prefabricated flashings for penetrations such as pipes, equipment curbs, braces and pitch pockets. These flashings shall be made of the same membrane as the roof sections. Hot-air weld the flashing's skirt to the roofing section and properly terminate the flashing to the penetration per the roof membrane manufacturer's specification.

F. Drains and Scuppers: Follow the roof membrane manufacturer's specification to properly terminate the roofing sections at drains and scuppers. Clamping rings may be used to terminate the roof section at roof drains. If the drain does not have a clamping ring, or it cannot be used, a prefabricated drain boot must be used. Prefabricated flashings must be utilized for scuppers.

3.05 FLASHING INSTALLATION

A. General:
   1. All penetrations must be at least 24" (61 cm) from curbs, walls, and edges to provide adequate space for proper flashing.
   2. Flash all perimeter, curb, and penetration conditions with coated metal, membrane flashing, and flashing accessories as appropriate to the site condition.
   3. All coated metal and membrane flashing corners shall be reinforced with preformed corners or non-reinforced membrane.
   4. Hot-air weld all flashing membranes, accessories, and coated metal. A minimum 2" wide (hand welder) weld is required.

B. Coated Metal Flashings:

1. Coated metal flashings shall be formed in accordance with current manufacturer construction details and SMACNA guidelines.
2. Coated metal sections used for roof edging, base flashing and coping shall be butted together with a ¼" gap to allow for expansion and contraction. Hot-air weld a 6" wide reinforced membrane flashing strip to both sides of the joint, with approximately 1" on either side of the joint left un-welded to allow for expansion and contraction. 2" wide aluminum tape can be installed over the joint as a bond-breaker, to prevent welding in this area.
3. Coated metal used for sealant pans, scupper inserts, corners of roof edging, base flashing and coping shall be overlapped or provided with separate metal pieces to create a continuous flange condition, and pop-riveted securely. Hot-air weld a 6" wide reinforced membrane flashing strip over all seams that will not be sealed during subsequent flashing installation.
4. Provide a ½" hem for all exposed metal edges to provide corrosion protection and edge reinforcement for improved durability.
5. Provide a ½" hem for all metal flange edges whenever possible to prevent wearing of the roofing and flashing membranes at the flange edge.
6. Coated metal flashings shall be nailed to treated wood nailers or otherwise mechanically attached to the roof deck, wall or curb substrates, in accordance with construction detail requirements.

C. Reinforced Membrane Flashings:
1. The thickness of the flashing membrane shall be the same as the thickness of the roofing membrane.
2. Membrane flashing may either be installed loose or fully adhered to the substrate surface in accordance with "Construction Detail Requirements".
3. Apply bonding adhesive at a rate resulting in 60 square feet/gallon of finished roofing material for solvent-based bonding adhesives, and at a rate of 125 square feet/gallon of finished roofing material for water-borne bonding adhesive. Apply bonding adhesive to both the underside of the membrane and the substrate surface at 120 square feet per gallon (Solvent Based) and 250 square feet per gallon (Water Based). A greater quantity of bonding adhesive may be required based upon the substrate surface condition. The bonding adhesive must be allowed to dry until tacky to the touch before flashing membrane application.
4. Apply the adhesive only when outside temperature is above 40°F. Recommended minimum application temperature is 50°F to allow for easier adhesive application.
5. The membrane flashing shall be carefully positioned prior to application to avoid wrinkles and buckles.

D. Un-reinforced Membrane Flashings:
1. Un-reinforced membrane is used to field-fabricate penetration or reinforcement flashings in locations where preformed corners and pipe boots cannot be properly installed.
2. Penetration flashings constructed of un-reinforced membrane are typically installed in two sections, a horizontal piece that extends onto the roofing membrane and a vertical piece that extends up the penetration. The two pieces are overlapped and hot-air welded together.
3. The un-reinforced membrane flashing shall be adhered to the penetration surface. Apply bonding adhesive at a rate resulting in 60 square feet/gallon of finished roofing material for solvent-based bonding adhesives, and at a rate of 125 square feet/gallon of finished roofing material for water-borne bonding adhesive. Apply bonding adhesive to both the underside of the membrane and the substrate surface at 120 square feet per gallon (Solvent Based) and 250 square feet per gallon (Water Based).The bonding adhesive must be allowed to dry until tacky to the touch before flashing membrane application.

E. Roof Edges:
   1. Roof edge flashings are applicable for gravel stop and drip edge conditions as well as for exterior edges of parapet walls.
   2. Flash roof edges with coated metal flanges nailed 4" o.c. to pressure-treated wood nailers. Hot-air weld roof membrane to metal flanges.
   3. When the fascia width exceeds 4", coated metal roof edging must be attached with a continuous cleat to secure the lower fascia edge. The cleat must be secured to the building no less than 12" o.c.
   4. Alternatively, roof edges may be flashed with a 2-piece snap on fascia system, adhering the roof membrane to a metal cant with bonding adhesive and face nailing the membrane 8" on center prior to installing a snap-on fascia (MA-206, 207).

F. Parapet and Building Walls:
   1. Flash walls with PVC membrane adhered to the substrate with bonding adhesive, loose applied (Less than 18" in height) or with coated metal flashing nailed 4" on center to pressure-treated wood nailers.
   2. Secure membrane flashing at the top edge with a termination bar. Water Block shall be applied between the wall surface and membrane flashing underneath all exposed termination bars. Exposed termination bars shall be mechanically fastened 8" on center; termination bars that are counter flashed shall be fastened 12" on center.
   3. Roof membrane must be mechanically attached along the base of walls with screws and plates (deck securement) or screws and inverted termination bar (wall securement) at the following rate:

Mechanically Attached Systems	Per in-lap on center spacing, with a 12" maximum
Fully Adhered Systems	12" on center

   4. All coated metal wall flashings and loose applied membrane flashings must be provided with separate metal counterflashings, or metal copings.
   5. Metal counterflashings may be optional with fully adhered flashings depending on guarantee requirements. Exposed termination bars must be sealed with appropriate caulking.

G. Curbs and Ducts:
   1. Flash curbs and ducts with PVC membrane adhered to the curb substrate with bonding adhesive, loose applied (Less than 18" in height) or with coated metal flashing nailed 4" on center to pressure-treated wood nailers.
   2. Secure membrane flashing at the top edge with a termination bar. Water Block shall be applied between the curb/duct surface and membrane flashing underneath all termination bars. Exposed termination bars shall be mechanically fastened every 8"o.c.; termination bars that are counter flashed shall be fastened 12" on center.
   3. Roof membrane must be mechanically attached along the base of walls with screws and plates (deck securement) or screws and inverted termination bar (wall securement) at the following rate:

Mechanically Attached Systems	Per in-lap on center spacing, with a 12" maximum
Fully Adhered Systems	12" on center

   4. All coated metal curb flashings and loose applied membrane flashings must be provided with separate metal counterflashings, or metal copings.
   5. Metal counterflashings may be optional with fully adhered flashings depending on guarantee requirements. Exposed termination bars must be sealed with appropriate caulking.

3.06 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to roof membrane according to the roof membrane manufacturer's specification.

3.07 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

B. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Warranty: Upon receipt of the required materials, certifying inspection and acceptance of the installation by the roof membrane manufacturer, the warranty shall be duly executed and issued to the Owner.

3.08 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by the roof membrane manufacturer.

END OF SECTION 07 54 00

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide all metal flashing and sheet metal work, as shown on the drawings and as herein specified.

B. Related Sections include the following:
   1. Division 04 Section - Unit Masonry for through-wall flashing.
   2. Division 06 Section - Rough Carpentry for blocking, nailers, etc.
   3. Division 07 Section - Joint Sealers.
   4. Division 07 Section - Painting.
   5. Division 07 Section - Roofing for flashing membranes.
   6. Division 07 Section - Roof Specialties for manufactured roof specialties not part of sheet metal flashing and trim.
   7. Division 07 Section - Roof Accessories for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
   8. Division 07 Section - Expansion Control for manufactured sheet metal expansion-joint covers.

1.03 PERFORMANCE REQUIREMENTS AND QUALITY ASSURANCE

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with the latest edition of NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
   1. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss. Account for temperature change of 120 deg F ambient, 180 deg F material surfaces.

D. Installer: Engage an experienced installer who has completed similar work of a comparable scale with a record of successful performance.

1.04 GUARANTEE

A. Sheet metal applicator and General Contractor shall personally guarantee sheet metal work for a period of Two-Years after acceptance of the building by the Owner against any defects

or water leaks. Guarantee shall include all labor and materials necessary to correct any defects or water leaks upon notice from the Owner.

B. Furnish manufacturer's standard 20 year warranty stating architectural fluorocarbon finish will be:
   1. Free of fading of color change in excess of 6 NBS units as measured per ASTM D 2244-68;
   2. Will not chalk in excess of numerical rating of 7 when measured in accordance with standard procedures specified in ASTM D 659-74;
   3. Will not peel, crack, chip, or de-laminate.

1.05 SUBMITTALS

A. Division 01 Section - Submittal Procedures: Procedures for submittals.

B. Submit shop drawings for review and approval prior to ordering of materials and fabrication of the required shapes and metal flashings. Submittal for the coping system is required.

C. Failure by the contractor to submit shop drawings required above shall release the Architect from any liabilities due to the negligence on the part of the Contractor to comply with the construction documents.

D. Samples: Submit samples of sheet metal flashings, trim, copings, accessory items, and prefinished items of profiles, gauge and finish to be used.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sheet metal for receivers and counter-flashings: 24 gauge or as noted on drawings galvanized sheet steel bent to required shapes.

B. Sheet metal for downspouts, leader boxes, scuppers, eave flashing, copings, gravel stops, gutters, drip edges and similar exposed items shall be 20 gauge hot-dip galvanized sheet steel. Bend to required shapes.

C. Stainless Steel Sheet: ASTM A 240 / A240M or ASTM A 666, type 304, dead soft, fully annealed. Provide sheet in 18 gauge thickness for jamb flashing.

D. Lead: Weight 4 lbs. per square foot.

E. Solder: ASTM D32, Alloy gauge 58, 50% tin, 50% lead.

F. Gutter, Downspout and Fascia at Canopies and Metal Roofing: 24 Gauge galvanized steel with Kynar 500 coating. Provide 1" straps at 30" o.c. and bracket hangers at 30" o.c. Gutter to be color as selected by Architect.

G. Shop-Fabricated Scupper: Fabricate from 24 Gauge galvanized steel with Kynar 500 finish. Formed one-piece through wall scupper flashing with flange extending at least 4" in all directions from scupper and at least 4" onto roof surface (4" beyond roof cants at overflow scuppers). Basis of Design construction shall be patterned on a scupper as manufactured by OMG Roofing Products or approved equal. Provide with prefinished Kynar snap-on face trim in color as selected by the Architect.

H. Finish for Galvanized Steel: Kynar coating in colors as selected by Architect.

I. Nails for Sheet Metal Work: 10 Gauge galvanized ring type steel of sufficient length to adequately secure sheet metal work.

J. Precast Concrete Splashblock: 12" x 24"; provide one per downspout or as indicated on drawings.

K. Aluminum Trim Fasteners: Exposed fasteners shall be aluminum or stainless steel. Unexposed fasteners may be cadmium or zinc plated steel in accordance with ASTM A164-55 and 165-55. Steel anchors shall be properly insulated from aluminum.

L. Roof Penetration Flashing: Lead coated copper 16 oz./SF. Roof Penetration Flashing: Lead coated copper 16 oz. /SF.

M. Through-Wall, Door/Window Sill and Head Flashings:
   1. Where embedded in masonry (not exposed to view): 3 oz. copper composite Multi-Flash 500 by York or approved equal.
   2. Where exposed to view: Prefinished 24 gauge galvanized steel with PVDF coating in color(s) as selected by Architect. Provide with drip edges hemmed 1/2" on underside.

N. Metal Jamb Flashing: Provide 18 gauge stainless steel, with hemmed edge.

O. Reglets: Equal to Fry original metal reglet.

P. Counter Flashing. "Springlock Flashing" by Fry Reglet.

Q. Sheet Metal Fasteners: Galvanized steel with washers where required.

R. Hooded Pans with Pourable Sealant: As detailed in drawings, constructed of 20 gauge galvanized sheet steel, riveted and soldered watertight. Provide hooded pans at all new pipe, conduit, refrigerant line and other similar through-roof penetrations as necessary where power / condensate do not penetrate within RTU roof curbs. Bed flanges with plastic cement (Fed. Spec. SS-C-153, Type II) on top of roofing. Caulk around penetrations. Fill pans with roofing granules to 1" from top, and fill to the top with pourable sealant. Mold sealant to cone shape sloping to outside.
   1. Provide pans of adequate sizes for penetrations as indicated in Drawings, including space between penetrations within the same hooded pan.

2.02 FABRICATION

A. All exposed edges shall be hemmed 1/2" on underside.

2.03 ALUMINUM FINISHES

A. General: Comply with Aluminum Association's (AA) "Designation System for Aluminum Finishes: for finish designations and application recommendations.

B. High-Performance Organic Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid chromate-fluoride-phosphate conversion coating; Organic Coating; as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.
   1. Fluoropolymer 2-Coat Coating system: Manufacturer's standard 2-coat, thermo cured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.
      a. Color and Gloss: As selected by Architect from manufacturer's full range of choices for color and gloss.

PART 3 - EXECUTION

3.01 INSPECTION OF SURFACES

A. Applicator responsible for inspecting substrates upon which sheet metal materials are to be placed for any defects or conditions that would impair finished installation. Application constitutes acceptance of the substrate.

3.02 APPLICATION

A. Details shown are design details, fabrication techniques, and methods as per SMACNA recommendations.

B. Proper and adequate provisions shall be made in fabrication, installing and fastening sheet metal work for expansion and contraction of metal and other materials entering into the work so that pulling, splitting, opening of joints, warpage or other failure of the work shall be prevented. Expansion joints in sheet metal placed not farther than 40 feet apart. Dissimilar metal surfaces contacting one another, protected by bituminous coating to prevent galvanic or corrosive action from occurring.

C. Counter flashing constructed in lengths not exceeding 10 feet and installed in receiver so that flashing lays tightly against base flashing and overlaps base flashings a minimum of 4 inches. Joints between sections shall be tight and lay flat. Metal at corners continuous. Bent, crimped or warped sections are not permitted.
   1. Coordinate counterflashings with roofing installation of termination bars at top edge of roofing base flashings.

D. Install hooded sealant filled pans at equipment supports, pipes, conduits and other items penetrating roof or at items resting on roof without integral curbs and base flashing. Bed flanges with plastic cement (Fed. Spec. SS-C-153, Type II) on top of roofing. Caulk around penetrations. Fill pans to 1" from top with roofing granules. Fill top inch of pans with pourable sealant and mold to cone shape sloping to outside.

3.03 INSTALLATION

A. General: unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by method indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.
   1. All complete work shall be water and weathertight. Joints, cuts, miters, splices or other installation means made as neat as possible. Fastenings as inconspicuous as possible.

B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicate, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Expansion Provisions: Provide for thermal expansion of exposed sheet metal work. Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less that 1 inch deep, filled with mastic sealant (concealed within joints).

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches, except where pretinned surface would show in finished Work.
   1. Do not solder the following metals:
      a. Aluminum.
   2. Pretinning is not required for the following metals:
      a. Lead-coated copper.
   3. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

E. Copings: Install with concealed splice plates, preformed corners, and positive drainage (inward slope) on top surface. No exposed fasteners through copings allowed.

F. Sealed Joints: Form no expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
   1. Use joint adhesive for nonmoving joints specified not to be soldered.

G. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

H. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
   1. Underlayment: Where installing stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.
   2. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.

I. Roof-drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA'S Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation.

J. Roof-Penetration Flashing; Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashing as follows:
   1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
   2. Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.

K. Splash Pans: Install where downspouts discharge on low-sloped roofs, unless otherwise shown. Set in roof cement or sealant compatible with roofing.

L. Precast Concrete Splash Blocks: Install where downspouts discharge on grade unless otherwise shown.

3.04 FLASHING & COUNTERFLASHING REQUIREMENTS

A. Joints in thru-wall flashings and counterflashings shall be lapped 4" minimum with laps bedded in sealant.

B. Head and sill flashings shall not have joints and shall have sides turned up (edge dams) with all corners folded, not cut and shall extend 9" minimum beyond both sides of opening.

C. Head, sill and thru-wall flashings shall be set in a bead of sealant applied under the exterior edge of the flashing and on top of the masonry or lintel angle on which the flashing rests.

D. Penetrations in thru-wall flashing are not permitted. Vents in thru-wall flashing shall be completely flashed and water tight.

E. Metal reglets shall have a bead of sealant installed to complete system with counterflashing.

F. All thru-wall flashing shall extend through and up the interior face of exterior gypsum sheathing, as applicable.

G. Install metal jamb flashing, in material as noted, over adjacent air barrier system at jambs of curtainwall and other locations as shown on the drawings, as required to close openings to cavity wall. Mechanically attach with stainless steel fasteners and seal metal flashing to wall / air barrier with self adhering membrane flashing as specified in Division 07 Section - Modified Bituminous Sheet Air Barriers.

3.05 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

END OF SECTION 07 62 00

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Pre-Manufactured Coping Systems.
   2. Pre-Manufactured Roof-edge drainage systems.
   3. Reglets and counterflashings.

B. Related Sections:
   1. Division 06 Section - Rough Carpentry for wood nailers, curbs, and blocking.
   2. Division 07 Section - SBS-Modified Bituminous Membrane Roofing for roof edge flashing system.
   3. Division 07 Section - Flashing and Sheet Metal for custom and site-fabricated sheet metal copings, flashing and trim.
   4. Division 07 Section - Roof Accessories for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
   5. Division 07 Section - Joint Sealants for field-applied sealants between roof specialties and adjacent materials.

1.03 PERFORMANCE REQUIREMENTS AND QUALITY ASSURANCE

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects roof specialties including installers of roofing materials and accessories.
   2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
   3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

C. Sheet Metal Standard for Flashing and Trim: Comply with the latest edition of NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
   1. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. Wind-Uplift Resistance: Provide metal roof edge flashing assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.

E. SPRI Wind Design Standard: Manufactured copings and roof edge flashings for low slope roofs shall be designed and installed for wind loads in accordance with IBC Chapter 16,

including local code amendments as applicable, and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI/FM 4435/ES-1.

1. Roof edge products shall be UL Classified by Underwriters Laboratories, Inc. or other building code approved 3rd party verification of compliance with the ANSI/SPRI/FM 4435/ES-1 Wind Design Standard.

F. Recycled Content of Copper-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**40**] <**Insert number**> percent.

G. Recycled Content of Steel-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] <**Insert number**> percent.

H. Recycled Content of Zinc-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**15**] <**Insert number**> percent.

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss. Account for temperature change of 120 deg F ambient, 180 deg F material surfaces.

J. Installer: Engage an experienced installer who has completed similar work of a comparable scale with a record of successful performance.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:

1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
3. Details of termination points and assemblies, including fixed points.
4. Details of special conditions.

C. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

D. Samples for Verification: For copings, roof-edge flashings, reglets and counterflashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

1.05 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings and roof-edge flashings.

B. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.07 WARRANTY

A. Coping System: Special Performance / 20-Year Warranty: Manufacturer shall guarantee that a coping system up to 32" wide, when installed per manufacturer's instructions, will not blow

off, leak, or cause membrane failure, even in wind conditions up to 110 mph, or the manufacturer shall at their option repair or replace their materials.

B. Furnish manufacturer's standard 20 year warranty stating architectural fluorocarbon finish will be:
   1. Free of fading of color change in excess of 6 NBS units as measured per ASTM D 2244-68;
   2. Will not chalk in excess of numerical rating of 7 when measured in accordance with standard procedures specified in ASTM D 659-74;
   3. Will not peel, crack, chip, or de-laminate.

C. Furnish written warranty signed by applicator for two year period from date of substantial completion of building covering repairs required to maintain roof and flashings in watertight conditions.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

PART 2 - PRODUCTS

2.01 EXPOSED METALS

A. Galvanized steel G90 with factory applied Kynar 500/Hylar 500 finish.

2.02 CONCEALED METALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.

2.03 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
      b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
      c. Henry Company; Blueskin PE200 HT.
      d. Owens Corning; WeatherLock Metal High Temperature Underlayment.

2.04 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.05 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 10 feet, concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide OMNG Roofing Products, "Permasnap-2" or "Permasnap-2 Plus" as recommended by manufacturer for specified performance criteria, or approved equal by another manufacturer.
   3. Coping-Cap Material: Galvanized steel, minimum of 22 gauge or greater where required by coping size or performance criteria, G90 with factory applied Kynar 500/Hylar 500 finish.
      a. Color: As selected by Architect from manufacturer's full range.
   4. Corners: Factory pre-formed, mitered and continuously welded.
   5. Splice Plates: Concealed, of same material & finish as coping.
   6. Special Fabrications: Two-way sloped coping cap.
   7. Coping-Cap Attachment Method: Face leg hooked to continuous cleat with snap-on back leg fastener exposed, fabricated from coping-cap material.
   8. Cleats are minimum of 20ga galvanized steel. Chairs are metal in the same color and finish as the coping cap. Fabricated to the wall width required between 6" and 32".
   9. Provide thicker gauges of cap and cleats than the minimum gauges as required to meet referenced standards and performance criteria. Contractor is responsible to determine where thicker gauges are required and include in their bid.

2.06 ROOF-EDGE FLASHING AND DRAINAGE SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products as pre-manufactured by OMG Roofing Products.

B. Overflow Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:
   1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch.

C. Precast Concrete Splashblock: 12" x 24"; provide one per downspout.

D. Splash Pans: Fabricate from the following exposed metal:
   1. Stainless Steel: 0.019 inch thick.

2.07 REGLETS AND COUNTERFLASHINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Fry Reglet Corporation or comparable product by one of the following:
   1. OMG Roofing Products.
   2. MM Systems Corporation.

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
   1. Galvanized steel (24 ga.) G90 with factory applied Kynar 500/Hylar 500 finish.
   2. Corners: Factory mitered and mechanically clinched and sealed watertight.
   3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 10 feet designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:
   1. Galvanized steel (24 ga.) G90 with factory applied Kynar 500/Hylar 500 finish.
      a. Color: As selected by Architect from manufacturer's full range.

D. Accessories:
   1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
   2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.08 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.03 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of self-adhering, high-temperature sheet underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 10 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1 recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints with elastomeric sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.04 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings to meet performance requirements.
1. The first cleat/chair set should be installed with the center line of the cleat set to the miter leg length (see chart on front page) and 24" (300mm) from the end of a wall. Install cleats/chairs sets at all corners and ends first, then work along the wall to the center locating sets every 60" on center for walls less than 17" and 40" on center for walls 17" - 32". Adjust the cleat location in the middle of a run to fit a short coping length. This procedure will provide a symmetrical appearance of the installed coping. Install metal gutter chair/concealed joint covers at joint locations. Hook coping face leg over the cleat face (front) leg and swing over the top. Snap the roof side (back) leg by pressing firmly down on the back edge directly over the cleat chair sets. Leave a 1/4" gap at each joint for thermal movement. Anchor shall be placed per manufacturer's required spacing that meets performance requirements.

3.05 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches apart. Attach ends with rivets and solder to make watertight. Slope to downspouts.
   1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion joint caps.
   2. Install continuous on roof blocking with stainless steel fasteners.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at 3 per 10 feet.
   1. Provide elbows at base of downspout to direct water away from building.

D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant.

3.06 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Embedded Reglets: See Division 04 Section - Unit Masonry Assemblies for installation of reglets.

C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.

D. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant. Fit counterflashings tightly to base flashings.

3.07 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 71 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide roof accessories including roof hatch, pre-fabricated roof curbs, pipe pedestals, pipe portals and other items as indicated on the drawings.

B. Related Sections include the following:
   1. Division 05 Section - Metal Fabrications, for coordination with roof access ladders.
   2. Division 06 Section - Rough Carpentry, for wood blocking.
   3. Division 07 Section - Roofing Section(s).
   4. Division 07 Section - Sheet Metal Flashing and Trim.
   5. Division 07 Section - Roof Specialties.
   6. Division 07 Section - Sealants.
   7. Division 22 Sections for Plumbing.
   8. Division 23 Sections for Mechanical.
   9. Division 26 Sections Electrical.

1.03 QUALITY ASSURANCE

A. Comply with "NRCA Roofing and Waterproofing Manual" for installation of units.

1.04 SUBMITTAL

A. Submit manufacturer technical product data and rough-in diagrams, details.

1.05 PRODUCT DELIVERY

A. Deliver products in manufacturers original unopened packages, clearly marked with brand name and model number.

B. Store materials on clean, raised platforms with weather protective covering when stored outdoors.

1.06 WARRANTY

A. Manufacturer shall guarantee against defects in material and workmanship for a period of five years.

1.07 PROJECT CONDITIONS

A. Any equipment curb heights indicated in Drawings are minimum curb heights required in general. Taller curbs may be required for minimum height above adjacent roofing for roof warranty, including tapered insulation and crickets. All curbs shall be tall enough to accommodate minimum curb height, or minimum heights above roof as indicated in Drawings, or minimum 8" above highest adjacent roof surface, whichever is greatest. Coordinate with roofing installer to confirm total curb heights required.

B. Do not install materials during inclement weather or when air temperature may fall below 40° F, including wind chill.

C. Do not install materials over damp, frozen or otherwise unsuitable surface.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturer's offering Products which may be incorporated in the Work include the following:
   1. Custom Curb, Incorporated, Chattanooga, TN (800) 262-6669.
   2. Kentuckiana Curb Company, Louisville, KY (800) 382-2872.
   3. The Pate Company, Broadview, IL (800) 243-3018.
   4. Thybar Corporation, Addison, IL (708) 543-5300.
   5. Bilco

B. Division 01 Section - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.02 MATERIALS

A. Prefabricated Roof Hatch: Unit shall be 3'-0" x 3'-0" for roof ladder access equal to Bilco, Type 'E' single leaf type. Frame with integral curb double wall construction with welded or sealed mechanical corner joints. Provide double wall cover with 1" insulation core. Equip unit with complete hardware set including hold open devices, interior padlock hasps and both interior and exterior latch handles. Unit shall be fully gasketed and completely fabricated of galvanized steel.
   1. Ladder Safety Post: Adaptable to steel or aluminum ladder at roof access. Device shall be manufactured of high strength steel with telescoping tubular section that locks automatically when fully extended. Upward and downward movement shall be by a stainless steel spring. Finish shall be black enamel. Equal to Bilco, "Model 1 Ladder Up."

B. Pre-fabricated Roof Curbs: Welded 18 gauge welded galvanized steel and integral base plate with factory installed 2 x 4 pressure treated wood nailer, insulation board and heavy gauge galvanized steel counterflashing. Reinforcing on sides greater than 36". Curbs to be provided at all mechanical roof top units and as shown on drawings. Unit shall be tapered to provide level rooftop units, as manufactured by the Pate Co., Model #PC-2, or approved equal.

C. Prefabricated Roof Equipment Support: Welded 18 gauge welded galvanized steel and integral base plate with factory installed 2 x 4 pressure treated wood nailer, and heavy gauge galvanized steel counterflashing. Reinforcing on sides greater than 36". Supports to be provided at all HVAC roof top condensers and as shown on drawings. Unit shall be tapered to provide level rooftop equipment, as manufactured by the Pate Co., Model #ES-2, or approved equal.

D. Pipe Pedestals: Freestanding pipe stand made of UV stabilized polycarbonate with nylon roller for piping up to 4". Miro Industries "Miron TPC" or equal.

E. Pipe Seal: One piece spun aluminum base with full five inch sloped-roof surface flange, graduated step PVC boot and adjustable stainless steel clamps equal to Pate "Pipe Seal", size as required by pipe.

F. Grease Guard at Kitchen Exhaust Fans: G2® Grease Guard® Rooftop Defense and Filtration System as manufactured by Dawg, Inc., or approved equal.

G. Accessories:
   1. Fasteners: Manufacturer's recommended gasketed fasteners for substrates and conditions indicated.
   2. Pipe Umbrellas: Provide one piece pipe umbrellas at roof pipe penetrations. Sizes to match penetrations indicated.
   3. Sealants: As recommended by Manufacturer for conditions and substrates indicated. Where sealants may be visible in completed work, sealant colors shall match roofing or adjacent materials as selected by Architect from available standard colors.

2.03 FABRICATION

A. Curb Cap Flashings: All curb cap flashings without exception shall be one piece galvanized steel construction with no rivets or sealant joints, and with pre-punched holes on vertical surface for mechanical fastener attachment to curbs. Except for equipment support curbs required to be a level mounting surface, top side of curb cap flashings shall have slight slope to drain away from penetrations on all sides. Penetration openings shall be fabricated to dimensions of penetrating items and shall turn up integral with flashing cap at least one inch, with a turned out lip for applying sealant, unless otherwise approved by Architect.

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate between trades as required to ensure waterproof installation acceptable to roofing installer and Manufacturer.
   1. Ensure roof curbs meet minimum height requirements above adjacent roofing, including insulation thickness, tapered insulation, and crickets.
   2. Verify and coordinate actual roof slopes as required for level top of curbs.
   3. Coordinate installation of roofing membrane pads under all support pedestals.

3.02 INSPECTION

A. Examine areas to receive roof accessories to insure work of preceding trades is completed. Check surfaces to see that they are uniform in place, free from grease, oil or other debris which would affect proper installation. Application constitutes acceptance of substrate conditions.

3.03 INSTALLATION

A. Accessories installed in accordance with current printed recommendations of Manufacturer and to roofing manufacturer's requirements.

B. Coordinate installation of accessories with roof and flashing installations. Provide weathertight installation.

C. Accessories secured in place to withstand wind loads in accordance with the local building codes.

D. Fasteners, General: All fasteners shall be installed straight and to make proper seal at gaskets. No fasteners of any sort are allowed through top side of curb cap flashings. All fasteners in flashing caps shall be through vertical sides only. No fasteners of any sort are allowed through roofing membranes or materials unless specifically approved in writing by roofing installer and manufacturer, and approved by Architect.

END OF SECTION 07 72 00

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Furnish all labor, materials, tools, equipment and related items required for the complete installation of firestopping at penetrations through rated partitions and floors.

B. Related Documents: The Contract Documents, as defined in Division 01 Section - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections include the following:
   1. Division 03 Section - Concrete Floor.
   2. Division 07 Section - Fire-resistive Joints.
   3. Division 09 Section - Drywall Partitions.

1.03 STANDARDS

A. All work under this section shall conform to the requirements of the Underwriters' Laboratories, Inc., the National Board of Fire Underwriters and the local building code. Where requirements specified differ from the requirements of any authorities having jurisdiction, the more stringent requirements shall apply.

B. Firestopping system shall be a complete system of materials supplied by one manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications of Installer:
   1. Five years experience in performing installation of materials with similar quantities of fireproofing materials.
   2. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

C. Requirements of regulatory agencies:
   1. Building code requirements of the municipality for fire resistance ratings of areas to receive fireproofing materials.
   2. Underwriters' Laboratories, Inc.: Classification marking.

3. Acceptance by ICBO, BOCA and SBCCI as described by National Evaluation Service Report, NER-332.

D. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
   1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Penetration firestopping is identical to those tested per testing standard referenced.

E. Testing:
   1. Fire resistant rating of assemblies - ASTM E-814.
   2. Compound shall meet all requirements of UL 1479.

1.05 SUBMITTALS

A. Test Reports
   1. Submit copies of fire test reports of fireproofing installation to substrate materials required.
   2. Submit certified test reports of acceptable testing agencies which perform testing in accordance with ASTM E-119 and E-84.

B. Manufacturer's Instruction: Furnish manufacturer's printed material specifications and installation instruction for each type of fireproofing.

C. Certificates:
   1. Furnish manufacturer's certification that materials meet or exceed specification requirements.
   2. Furnish applicators certification that material has been completed as specified to meet fire resistance ratings and application requirements.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unopened packages bearing name of manufacturer and product identification.

B. Reject damaged packages found unsuitable for use and remove from job site.

C. Store materials off ground, under cover, and away from damp surfaces.

D. Keep materials dry at all times.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. Horizontal assemblies include floors, floor/ceiling assemblies, & ceiling membranes of roof/ceiling assemblies.
   2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
   3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

B. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

C. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

2.02 MATERIALS

A. Safing Insulation: Forming material, minimum 3" unfaced safing insulation with a nominal density of 4 pcf, and bearing the UL Classification Marking shall be "Thermafiber" as manufactured by Owens Corning.

B. Compound: Pliable, non-toxic, non-combustible, non-asbestos, low density, lightweight compound shall be "Firecode" as manufactured by USG Corp., "Flame Stop V" as manufactured by Flame Stop Inc. or "Metacaulk" as manufactured by Rectorseal.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that all substrates to receive firestopping system are constructed according to the Construction Documents and acceptable to receive fire stop materials.

3.02 APPLICATION

A. Safing Insulation: Cut safing insulation slightly wider than the opening. Compress and tightly fit min. 2 1/2" or 3" thickness of insulation with nominal density of 4 pcf completely around penetrant.

B. Firestopping Compound: Trowel apply the compound from its container and work into the penetration opening. Apply compound to minimum 1/2" to 1" thickness on top of safing insulation. Ensure that compound is in contact with all surfaces and that entire opening is filled with safing and compound. Utilize appropriately rated product for specific rated partition application.

END OF SECTION 07 84 13

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: Provide sealant required to close joints that would allow moisture or air to enter structure between fixed materials, as shown on the drawings and as herein specified, including but not limited to:
   1. Sealing of interior perimeter joints of window framing, door frames, and other openings in walls.
   2. Setting of thresholds in sealant.
   3. Sealing of joints between countertops and wall surfaces for a sanitary joint.
   4. Sealing of joints of every nature and description that would allow moisture or air penetration.
   5. Sealing of joints indicated to be caulked or sealed whether specifically mentioned herein or not.
   6. Sealing around all pipe, duct and vent penetrations.
   7. Sealing at paving joints.

B. Related Sections include the following:
   1. Division 04 Section - Unit Masonry Assemblies.
   2. Division 04 Section – Stone Masonry
   3. Division 06 Section - Interior Architectural Woodworking.
   4. Division 07 Section - Sheet Metal Flashing and Trim.
   5. Division 07 Section - Metal Panels.
   6. Division 07 Section - Roofing.
   7. Division 07 Section - Expansion Control.
   8. Division 08 Section - Aluminum Entrances and Storefront.
   9. Division 09 Section - Tiling.
   10. Division 09 Section - Gypsum Board Assemblies.
   11. Division 09 Section - Painting.
   12. Division 21 Section - Fire Suppression.
   13. Division 22 Section - Plumbing.
   14. Division 23 Section - Mechanical.
   15. Division 26 Section - Electrical.
   16. Division 32 Section - Paving.

1.03 JOB CONDITIONS

A. Environmental Conditions: Sealant work not permitted when air temperature is below 40 degrees F.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, color range, handling/installation/curing instructions, and performance tested data sheets for each elastomeric product or joint backing material.

B. Samples: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Submit samples of joint backing material.

1.05 WARRANTY

A. The Contractor shall submit, in writing, a warrant that all sealant work executed under this Section shall be free from defects in materials and workmanship for a period of two (2) years from date of acceptance of the Project, and he shall remedy any defects in the sealant work during the warranty period.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Architectural Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

2.02 MATERIALS

A. Chemical Compatibility, General: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
   1. Where new sealants will adjoin existing sealants to remain, confirm chemical compatibility of sealant type prior to preparing submittals. In the event of chemical incompatbility, suggest alternate compatible sealant products for those applications.

B. Primers: Non-staining type as recommended by sealant manufacturer for each working surface. Material shall not leave residue or stain on adjacent surfaces. Each joint must be primed prior to sealing.

C. Sealant for Interior and Exterior Masonry Control Joints: 1 part ultra low modulus silicone sealant equivalent to "Spectrum 1" by Tremco, or "890 NST" by Pecora**.** Color to match adjacent surfaces.

D. Sealant for Re-glazing: Medium modulus silicone sealant shall be Tremco's "Spectrem 2", or approved equal. Color as selected by Architect.

E. Sealant for Exterior Concrete Paving and Sidewalk Joints: Two part urethane (self leveling) sealant equal to "MasterSeal SL-2" by Sonneborne / BASF Chemical Co., "Urexpan NR-200" by Pecora, or "THC-900" Tremco. Provide non-sag product at joints in vertical curbs, equal to "MasterSeal NP-2" by Sonneborne / BASF.

F. Caulking for Interior Joints: One part acrylic latex sealant equivalent to "AC-20" by Pecora, "Tremflex 834" by Tremco, "Acrylic Latex" caulk by DAP, or "Sonolac" by Sonneborn.

G. Caulking for Countertop Joints: One-part clear silicone sealant, 860 by Pecora, or equal.

H. Precompressed Expanding Foam Sealant: Shall be Gray "Illmod 600" as manufactured by "Tremco", Beachwood, Ohio or approved equal.

I. Sealant for Gypsum Board joints for Acoustic Construction: USG "Acoustical Sealant" or equal by Tremco or Pecora.

J. Sealant for Windows for Acoustic Construction: Closed-cell polyvinyl chloride foam sealant with pressure-sensitive adhesive on one side; Norton® V740 Multipurpose Pressure Sensitive Adhesive Sealant Foam manufactured by Saint-Gobain.

K. Closed-cell tape sponge neoprene for Acoustic Construction: 1/4" x 1", Press-on Products (800-323-7467 or 630-628-2255), Part No. P-8200 or P-8100.

L. Non-Hardening Sealant for Acoustic Construction
   1. Non-hardening polyurethane type, ASTM C920, Type M, Class 25, Grade NS: Tremco "Dymeric 511" or approved equal.
   2. Non-hardening polysulphide type, ASTM C920, one-part: Pecora "GC-9" or approved equal.
   3. Non-hardening silicone type, ASTM C920, Type S, Class 25, Grade NS, one-part, low modulus type: GE "Silpruf", Dow Corning 790, Tremco "Spectrum 1", Pecora 864, or approved equal..

M. Joint Backing: ASTM C1330, Non-staining closed cell polyethylene foam rod oversized 30% to 50%, equal to "MasterSeal 920" by BASF.

N. Foam Backer Rod for Acoustic Construction: ASTM C1330, Closed cell polyethylene,. Acceptable Manufacturers: ITP, Nomeco, or approved equal. (Available through Tom Brown, Inc. 800-446-2298)

O. Solvents and Cleaning Agents: Of a type specifically recommended by sealant manufacturer.

PART 3 - EXECUTION

3.01 INSPECTION

A. Applicator shall examine surfaces receiving sealant or caulking for any defects or joint sizes which would not structurally perform or for any unusual conditions which would interfere with proper installation of sealant or caulking.

3.02 PREPARATION

A. Thoroughly clean all joints removing all foreign matter such as dust, oil, grease, dirt or other loose particles. Provide and apply non-staining primer as required by conditions and sealant manufacturer.

B. When primer is dry, compress backup and insert into joint leaving 1/4" to surface open for joint sealing or leave open 1/2 of joint width, but not less that 1/4".

C. Completely cut smooth and remove projection of existing gasket and/or sealant material at door and window framing to remain to achieve sound substrate for application.

3.03 APPLICATION

A. It is the intent and purpose and interpretation of this specification that in all areas, joints sealed shall be rendered structurally sound and impervious to the passage of water, moisture and dust.

B. Follow sealant manufacturer's instructions regarding mixing, surface application, priming and application procedure.

C. Sealant shall be applied under pressure with a hand or power activated gun having a nozzle of proper size to entirely fill joint void and shall be forced into joints with sufficient pressure to expel air and fill the joints solidly. All joint surfaces shall be neatly tooled to a smooth surface, free of wrinkles and result in a flush joint when dry.

D. Apply sealants when the ambient temperature is between 40° and 100° F.

E. All junctures between countertops, back splashes and walls shall be caulked with silicone sealant providing a sanitary tight joint.

F. All junctures between piping and substrate of partitions, floors and ceiling shall be caulked.

G. Precompressed expanding foam sealant shall be installed per manufacturer's requirements at all vertical expansion joints as noted on Drawings.

H. Apply sealant bead at least 1/2 inch thick under each edge of threshold. Remove excess and neatly point.

I. Apply sealant between brick veneer and coping on outside face of exterior wall.

J. Caulk perimeter of window frame, door frame or other items penetrating, intersecting or abutting walls, ceilings, floors, etc.

K. Prime surface as required and apply sealant at all glazing, at metal to metal and glass to metal joints within the system.

L. Apply bead of sealant at base of wall board.

M. Furnish and install acoustical sealant at the following locations:
   1. All penetrations of partition, wall, and floor construction by ductwork, conduit, piping, or structure.
   2. All termination of partitions enclosing Noise Critical Spaces to abutting construction (e.g. partitions, structure, etc.)
   3. Both sides of door frames to abutting construction where doors are scheduled to have acoustical seals.
   4. Both sides of window frames to adjacent construction
   5. Perimeter of and penetrations through sound isolating ceilings, roof systems, and floor systems.

N. Backer Rod shall be used in all joints, product to be constructed of closed cell foam, or appropriate resilient material for sealant. Dimension shall be minimum 30% greater than joint width, unless otherwise indicated on details.

O. Fill paving sealant full width of joint, and to within 1/8" of paving surface.

3.04 CLEANING

A. Clean adjacent surfaces free of sealant or soiling resulting from this work as work progresses. Use solvent or cleaning agent as recommended by sealant manufacturer. All finished work shall be left in a neat, clean condition.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide hollow metal doors and frames as shown on the Drawings and as herein specified.

B. Related Sections include the following:
   1. Division 04 Section - Masonry.
   2. Division 06 Section - Rough Carpentry.
   3. Division 07 Section - Flashing, Sheet Metal.
   4. Division 08 Section - Finish Hardware.
   5. Division 08 Section - Glazing.
   6. Division 09 Section - Gypsum Board.
   7. Division 09 Section - Painting.

1.03 QUALITY ASSURANCE

A. Design Criteria: Doors and frames noted to have a specific hourly label, shall be Underwriter's Laboratories, Inc. labeled construction shall bear the required UL label.

1.04 SUBMITTALS

A. Manufacturer shall furnish a certificate to the Owner evidencing that materials delivered meet the labeled and/or fire resistive construction requirements.

B. Shop drawings and details based on the Contract Documents shall be submitted to the Architect for review prior to fabrication of materials. Shop drawings shall indicate all hardware mounting heights, reinforcement, opening sizes, etc..

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Material: Individually packaged in cartons, completely protecting frames.

B. Frames shall be stored under cover on wood sills that will prevent rust and damage.

1.06 JOB CONDITIONS

A. Coordination
   1. The Contractor shall provide door and frame manufacturer with an approved hardware schedule, templates and hand for all doors. Contractor shall advise door and frame manufacturer of any changes after information has been forwarded.
   2. Contractor will be completely responsible for coordination of information between hardware, door and frame manufacturer. Contractor shall coordinate throat dimensions and clearance at thresholds and sill conditions with adjacent construction. Any materials not properly coordinated shall be replaced by the Contractor at his own expense.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ceco Door Products; an Assa Abloy Group company
   2. Firedoor Corporation
   3. Karpen Steel Custom Doors & Frames
   4. Mesker Door, Inc.
   5. Republic Doors and Frames

2.02 MATERIALS

A. Exterior and Interior Door Frames: ANSI/SDI A250.8, in depth and profiles indicated to suit application, furnished with 2" faces (4" head at masonry) and 5/8" stops. Strike jambs provided with 3 factory installed rubber bumpers. Provide UL rating as required. Frames fabricated of quality 16 gauge annealed steel.
   1. Removable stops at exterior frames located at interior side of frames for security and at interior side at upper floor level(s).
   2. Removable stops at interior frames located at interior (room) side of interior frames.

B. Door Frame Anchorage Devices: Provide with minimum of 6 wall anchors and 2 adjustable base anchors, manufacturer's standard design. Provide UL anchors as required. Contractor is responsible to coordinate anchor types required with adjacent construction.

C. Flush Doors: ANSI/SDI A250.8, 1-3/4" Flush type door with no visible edge seams. Polyurethane core or laminated of impregnated honeycomb cores. Reinforcements provided for all hardware. Exterior doors, and doors between conditioned and unconditioned spaces, shall have minimum R factor of 4.75 and flush closing channel at top rail. Doors mortised for hardware. Provide louvers and fire rating as required.
   1. Faces constructed of quality annealed steel as follows:
      a. Extra Heavy Duty (Level 3), 16 gauge steel at exterior doors and doors opening to the apparatus bay.
      b. Heavy Duty (Level 2), 18 gauge steel at interior doors.
   2. Use other core type(s) where required to achieve indicated R-values, STC ratings, and fire ratings, as approved by Architect.
   3. Door louvers: Provide manufacturers standard flush louver.

D. Divided Lite Door: 16 Gauge, 1-3/4" x 5" tubular top and side stiles and 10" bottom rail with mitered, face-welded corners. Doors shall be mortised, reinforced, drilled and tapped to receive mortise hardware. Door shall be similar to Ceco "Imperial", or approved equal. Provide insulated metal panel or 1/4" tempered glass as shown on drawings.

E. Accessory Materials: Provide complete fasteners, miscellaneous materials and accessories as required for complete installation including but not necessarily limited to the following:
   1. Grout mix shall provide a 4" maximum slump consistency, hand troweled in place. Grout mixed to a thin "pumpable" consistency shall not be used. Coordinate grout filled frames so as to not impede installation of electric strike/access control components.

2.03 FABRICATION

A. Frames shall have all joints mitered, continuous full welded and ground smooth. No putty or filler permitted at joints.

B. All door frames mortised for 1-1/2 pair 4-1/2 x 4-1/2 standard weight hinges. Frames of 48" width shall have 2 pair butts. (Re: Door Schedule and Hardware Schedule for Number and Location.) Frames mortised and reinforced for hinges, (7 ga. 1-1/4" x 10" min.), strikes, (12 gauge steel), and surface applied hardware, (12 ga. steel), as required.

C. All door frames shall be prepared for installation of silencers.

2.04 FINISH

A. All material shall be thoroughly cleaned and phosphatized prior to application of baked-on rust resistant prime coat of paint.

B. Doors and Frames for exterior openings shall be galvanized before primer is applied using a hot-dip coating of zinc.

C. Steel Knock-Down Frames:
   1. Factory primed for field painting. Refer to Division 09, Section "Painting".

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide filler plate and bond-o patching and sand smooth as required to eliminate evidence of patching in completed work.

B. Anchor ceiling struts to construction above with fasteners to suit conditions. Brace frames as necessary until built into permanent construction.

C. Exercise extreme care when installing door frames. All door frames which are installed out of plumb, distorted and not level or in a manner which does not permit proper installation of doors, must be removed and replaced with new frames in a manner satisfactory to the Architect.
   1. Knock-down frames installed with tight miter joints at corners and meeting at corners without any noticeable lip between head and jamb pieces.

D. Clearances:
   1. Allow maximum of 1/16" clearance at head and jamb.
   2. Allow maximum of 1/2" clearance at floors.
   3. Allow maximum of 1/4" clearance at thresholds.

E. All exterior door frames, doors between apparatus bay and living quarters shall be grouted solid. Close off openings to wall cavities as indicated in Drawings and as required.

F. Pack acoustical insulation continuously into frames at all partitions calling for acoustical insulation in the wall assembly.

3.02 PROTECTION AND CLEANING

A. Protect metal doors and frames and their finishes from damage and detrimental soiling during the remainder of construction.
   1. Repair and repaint hollow metal that is damaged or soiled, to eliminate evidence of damage, in a manner acceptable to Architect. Replace components that cannot be repaired.
   2. Replace knock-down frame components with damaged finish.

B. Clean doors and frames prior to inspection for substantial completion. Touch up paint finish as required. Clean with products that will not damage finishes.

END OF SECTION 08 11 13

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Solid-core doors with wood-veneer faces.
   2. Factory finishing of flush wood doors.
   3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:
   1. Division 04 Section "Unit Masonry Assemblies".
   2. Division 06 Section "Wood Framing".
   3. Division 08 Section "Metal Doors and Frames".
   4. Division 08 Section "Door Hardware".
   5. Division 08 Section "Glazing" for glass view panels in flush wood doors.
   6. Division 09 Section "Gypsum Board Assemblies".
   7. Division 09 Sections "Painting" for field finishing and touch-up of wood doors.

1.03 ACTION SUBMITTALS

A. Concurrent Review: Submit all door-related submittals together for concurrent review.

B. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   1. Indicate dimensions and locations of mortises and holes for hardware.
   2. Indicate dimensions and locations of cutouts.
   3. Indicate requirements for veneer matching.
   4. Indicate doors to be factory finished and finish requirements.
   5. Indicate fire-protection ratings for fire-rated doors.

D. Samples for Initial Selection:
   1. For factory-finished doors.
   2. Manufacturer's samples or selectors for louvers, frames, and other prefinished materials as applicable.

E. Samples for Verification:
   1. Factory finishes applied to actual door face materials, approximately 6 by 8 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
   2. Samples for frames for louvers and light openings, 6 inches long, for each material, type, and finish required.

1.04 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors from single manufacturer.

B. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on NFPA 252.

D. Preinstallation Conference: Conduct conference at Project Site to comply with Division 01, Section "Project Management and Coordination".

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Deliver doors to building after wet trades have been completed and building is within normal occupancy humidity conditions.

C. Doors shall be delivered in manufacturer's name and identifying symbol on covering.

D. Package doors individually in plastic bags or cardboard cartons.

E. Doors shall be stored flat with protective coverings provided to protect surfaces.

F. Doors shall not be dragged over one another.

G. Mark each door on top or bottom rail with opening number used on Shop Drawings.

1.07 PROJECT CONDITIONS

A. Comply with Manufacturer's environmental limitations. Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Coordination:
   1. The Contractor shall provide door manufacturer with approved hardware schedules, templates and hand for all doors. Contractor shall advise door manufacturer of any changes after information has been forwarded. Contractor will be completely responsible for coordination between hardware, door and frame manufacturers. Any materials not properly coordinated shall be replaced by the Contractor at his own expense.
   2. Door manufacturer shall be responsible for properly coordinating information received by him so that doors are properly finished, machined and ready to hang.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
      b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following**:**
   1. Algoma Hardwoods, Inc.
   2. Graham and Maiman.
   3. Haley Brothers, Inc.
   4. Mohawk Flush Doors, Inc.

2.02 DOOR CONSTRUCTION, GENERAL

A. Solid Wood Block Core Doors: 1-3/4 inch thick solid core wood doors with hardwood edges conforming to AWI Section 1300-G-3 for Type SLC-5 standards, bonded with exterior water-resistant, Type II resin glue.

B. WDMA I.S.1-A Performance Grade:
   1. Heavy Duty unless otherwise indicated.

C. Structural-Composite-Lumber-Core Doors:
   1. Structural Composite Lumber: WDMA I.S.10.
      a. Screw Withdrawal, Face: 700 lbf.
      b. Screw Withdrawal, Edge: 400 lbf.

D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

E. Mineral-Core Doors:
   1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
   2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
   3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

F. Particleboard-Core Doors: Not Allowed.

2.03 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Finish for Veneer-Faced Doors:
   1. Grade: Premium, with Grade A faces or better.
   2. Species: White oak, coordinate with millwork species.
   3. Cut: Rift cut.
   4. Match between Veneer Leaves: Book match.
   5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
   6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
   7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
   8. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.

B. Interior Solid-Core Doors:
   1. Exposed Vertical Edges: Same species as faces or a compatible species.
   2. Core: Structural composite lumber
   3. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.
   4. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.04 LOUVERS AND LIGHT FRAMES

A. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
   1. Wood Species: Same species as door faces.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Louvers Inc.
   2. Anemostat; a Mestek company.
   3. Hiawatha Incorporated.
   4. L & L Louvers, Inc.
   5. LL Building Products, Inc.; a division of GAF Materials Corporation.
   6. Louvers & Dampers, Inc.; a Mestek company.

C. Metal Louvers:
   1. Blade Type: Vision-proof, inverted V or Vision-proof, inverted Y.
   2. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, factory primed for paint finish.

D. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
   1. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, factory primed for paint finish.

E. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
   1. Wood Species: Same species as door faces.
   2. Profile: Flush rectangular beads
   3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

2.05 FABRICATION

A. Prefit and pre-machine wood doors at the factory.

B. Comply with the tolerance requirements of NWMA for prefitting. Machine doors for hardware requiring cutting of doors. Comply with final hardware scheduled and door frame shop drawings, and with hardware templates and other essential information required to ensure proper fit of doors and hardware.

C. Take accurate field measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with machining in the factory.

D. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Provide flush edgings for wood doors receiving panic devices or other hardware where typical molding would conflict with hardware. Coordinate with door hardware.
   3. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing."
   4. Louvers: Factory install louvers in prepared openings.

2.06 SHOP PRIMING

A. Doors for Transparent Finish: Shop prime doors, light beads and other trim pieces with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section "Painting". Seal all four edges, edges of cutouts, and mortises with first coat of finish.

2.07 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory that are indicated to receive transparent finish.

C. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Transparent Finish:
   1. Grade: Premium
   2. Finish: AWI conversion varnish or catalyzed polyurethane system.
   3. Staining: Match Architect's sample.
   4. Effect: Semi-filled finish, produced by applying an additional finish coat to partially fill the wood pores.
   5. Sheen: Semi-gloss.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine doors and installed door frames before hanging doors.
   1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Clearance Tolerances for Factory Fitted Doors: Align in frames for uniform clearance at each edge.
   1. Provide 1/8 inch at heads, jambs, and between pairs of doors.
   2. Allow maximum of 3/16" over threshold or saddle.
   3. Allow maximum of 1/2" over decorative floor coverings.
   4. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.

D. Clearance Tolerances for Fire-Rated Doors: Install in accordance with NFPA 80 for fire rated doors, and the following maximum clearances, whichever is more stringent:
   1. 1/8" between door and frame.
   2. 3/8" between door bottoms and decorative floor finish.
   3. 1/8" between doors for pairs of doors.

4. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 ADJUSTING

A. Operation: Re-hang or replace doors that do not swing or operate freely. Replace damaged material.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

C. Protect doors as recommended by door manufacturer to ensure that doors will not be damaged at time of Substantial Completion.

END OF SECTION 08 14 16

SECTION 08 14 33 - STILE AND RAIL WOOD DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Interior stile and rail wood doors.
   2. Shop staining stile and rail wood doors.
   3. Factory fitting stile and rail wood doors to frames and factory machining for hardware.

B. Related Sections include the following:
   1. Division 8 Section – Flush Wood Doors.
   2. Division 9 Section - Painting.

1.03 SUBMITTALS

A. Product Data: For each type of door. Include details of construction.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data.
   1. Indicate dimensions and locations of mortises and holes for hardware.
   2. Indicate requirements for veneer matching.

C. Product Certificates: Signed by door manufacturers.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain stile and rail wood doors through one source from a single manufacturer.

B. Quality Standard for Doors of Stock Design and Construction: Comply with WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," unless more stringent requirements are specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in opaque plastic bags or cardboard cartons.

C. Mark each door on top and bottom edge with opening number used on Shop Drawings.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Use only materials that comply with referenced quality standards unless more stringent requirements are specified.
   1. Assemble interior doors, frames, and sidelites, including components, with either dry-use or wet-use adhesives complying with ASTM D 5572 for finger joints and ASTM D 5751 for joints other than finger joints.

2.02 STILE AND RAIL DOORS

A. Available Manufacturers:
   1. JELD-WEN, Inc.
   2. Steves & Sons
   3. Eggers Industries; Architectural Door Division.
   4. Simpson Door Company.
   5. Masonite International.

B. Interior Sliding Barn Doors:
   1. Solid-core engineered wood-panel constructed to resist splitting, cracking, swelling and shrinking, warping, bowing, twisting, and cupping.
   2. Species: White Oak or compatible species coordinated with flush wood doors.
   3. Grade for Transparent Finish: Premium or Select.
   4. Flat-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated.
   5. Refer to drawings for aesthetic requirements sliding barn doors.

2.03 FABRICATION

A. Factory fit doors to suit opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:
   1. Clearances: Provide 1/2 inch from bottom of door to top of decorative floor finish or covering.
   2. For stile and rail doors used in sliding barn-door applications, provide a minimum 1/2 inch overlap over jambs and head of finished opening(s).
   3. Maintain minimum clearance from backside of door to face of wall, at a uniform distance throughout entire range of sliding door travel.

B. Factory machine doors for hardware that complies with final hardware schedules, door Shop Drawings, and other requirements provided in the Contract Documents.

2.04 SHOP PRIMING

A. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section "Painting". Seal all four edges and edges of cutouts/machining with first coat of finish.

2.05 FINISHING

A. Transparent Finish:
   1. Grade: Premium or select
   2. Finish: AWI conversion varnish or catalyzed polyurethane system.
   3. Staining: Match Architect's sample.
   4. Sheen: Semi-gloss.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."

B. Install wood doors to comply with manufacturer's written instructions and with referenced quality standard, and as indicated.

C. Field-Finished Doors: Refer to the following for finishing requirements:
   1. Division 9 Section "Painting."

3.03 ADJUSTING AND PROTECTING

A. Operation: Re-hang or replace doors that do not operate freely and that do not remain in the open or closed position as intended for normal operation.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

C. Protect doors to ensure that doors will not be damaged at time of Substantial Completion.

END OF SECTION 08 14 33

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Provide all access doors and frames for walls and ceilings as indicated in Drawings and as required for access to equipment and by authorities having jurisdiction, whether or not locations for access doors and frames are specifically indicated in Drawings.
   2. Floor access doors.

B. Related Sections include the following:
   1. Division 04 Section "Unit Masonry Assemblies".
   2. Division 04 Section “Stone Masonry” for access panels in Stone Veneer.
   3. Division 06 "Rough Carpentry" for coordination of wood blocking.
   4. Division 09 Section "Gypsum Board" for gypsum board assemblies.
   5. Division 09 Section "Acoustical Ceilings" for suspended acoustical tile ceilings.
   6. Division 09 Section "Wood Ceilings" for wood ceiling lay-in access panels.
   7. Division 09 Section "Ceramic Tiling".
   8. Division 23 Section "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.03 SUBMITTALS

A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.

C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items with concealed framing, suspension systems, piping, ductwork, and other construction. Show the following:
   1. Method of attaching door frames to surrounding construction.
   2. Ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain access doors and frames of each type through one source from a single manufacturer.

B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. NFPA 252 for vertical access doors and frames.
   2. ASTM E 119 for horizontal access doors and frames.

C. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.05 COORDINATION

A. Verification: Coordinate with other trades to determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, electrical, or other concealed work.
   1. Size panels as required by controls to be accessed. Provide adequate sizes to service equipment accessed by doors and panels, and acceptable to authorities having jurisdiction.
   2. For replacement of access doors in existing construction, field measure to match existing opening sizes.

1.06 PRODUCT DELIVERY AND STORAGE

A. Deliver products in manufacturers original packages, clearly marked with brand name and model number.

1.07 WARRANTY

A. Manufacturer shall guarantee against defects in material and workmanship for a period of five years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Access Doors:
      a. Acoustical Products, Inc.
      b. Acudor Products, Inc.
      c. Bilco
      d. Babcock Davis
      e. J. L. Industries, Inc.
      f. Karp Associates, Inc.
      g. Larsen's Manufacturing Company.

2.02 WALL AND CEILING ACCESS DOORS AND PANELS

A. Access Door for use in noise critical spaces: Equal to Type RDW manufactured by Karp with applied 5/8" drywall panel and factory-optional 1/16" x 3/8' neoprene gasket.

B. Ceiling Access Door (where passage is required for service access) at ceilings: Access panel with 5/8" gypsum board inlay, recessed aluminum extrusion frame, concealed non corroding two point pin hinge, and cylinder lock & key, equal to Acudor Products, Inc., DW5040
   1. Size: 30" x 30" where intended for passage, and sizes as required for intended service purpose in other locations.
   2. Fire rated to match adjacent construction when located in fire rated construction.

C. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
   1. Locations: Wall surfaces and ceilings. Install at all location where valves, controls, and other equipment are concealed within walls or hard (non-Acoustical Tile) ceilings, whether shown on the drawings or not.
   2. Door: Minimum 0.060-inch thick, 16 gauge sheet metal, set flush with exposed face flange of frame.
   3. Frame: Minimum 0.060-inch thick, 16 gauge sheet metal with nominal 1-inch-wide, surface-mounted trim.
   4. Fire rated to match adjacent construction when located in fire rated construction.

5. Hinges: Continuous piano hinge.
6. Latch: Screwdriver-operated cam latch or keyed lock, verify with Owner.
7. Finish:
    a. Satin stainless steel at tile, restrooms, and other wet locations.
    b. Shop primed steel for field applied painting in other painted wall **[and ceiling]** locations. Color to match adjacent finish.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas to receive door and frame to insure work of preceding trades is completed. Check surfaces to see that they are plumb in place, free from grease, oil or other debris which would affect proper installation. Application constitutes acceptance of substrate conditions.

3.02 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.

C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

D. Installation: All access panel locations in Noise Critical Spaces shall be installed only where indicated on drawings. Location of additional proposed access panels shall be submitted by Contractor for approval.

3.03 ADJUSTING AND CLEANING

A. Adjust doors and hardware after installation for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 08 35 13 - ELECTRIC OPERATED FOUR-FOLD DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Furnish and install insulated metal four-fold power operated doors and related work necessary for a complete installation as shown, specified and required for doors and controls.

B. Related Sections:

1. Division 04 Section "Unit Masonry Assemblies."
2. Division 05 Section "Structural Steel Framing."
3. Division 08 Section “Aluminum Storefronts and Entrances.”, for coordination of door color with aluminum storefronts.
4. Division 08 Section "Glazing."
5. Division 09 Section "Painting."
6. Division 26, for Electrical requirements, and coordination of power and controls.

1.03 PERFORMANCE REQUIREMENTS

A. Doors system designed to withstand external or internal wind loads of 20 psf, and also wind loading as required per local code requirements, whichever is greater. Maximum deflection shall not exceed l/120 of the span. Steel frames designed in accordance with AISC “Steel Construction Manual”.

B. Obtain doors, operators, hardware, and other accessories from a single manufacturer for sole sourced manufacturer warranty.

C. Specified control units are to establish quality and performance criteria. Design and provide complete controls for four-fold doors operate as described, whether or not specified control units can perform the described operation without modifications. General Contractor, Four-Fold Door manufacturers and installers, and the Electrical contractor shall fully coordinate requirements for these controls and shall provide a complete control system and related infrastructure:

1. Four-fold doors shall be controlled individually by 3-button controls at the following locations (refer to Electrical drawings):

a. At the jamb adjacent to each opening.

b. At both air locks.

c. Additionally, all front bay doors shall be controlled to all open by single press of a red mushroom button located in each air lock.

2. Four-fold doors shall be capable of receiving control input to open and close from the station alerting system.

3. Four-fold doors shall be controlled individually by radio frequency controls, and as follows:

a. Doors shall be controlled such that each bay works with the Fire Department's existing universal transmitters that are used for all of their Fire Stations. Contractor is responsible to coordinate requirements for this operation with the Fire Department, and to fully test each opening. Provide supplementary receivers where required to match required frequency and codes.

b. Provide a supplementary long-range receiver (with minimum of 300 ft range) for each door on the front exit side of the apparatus bays. This receiver is in addition to the interior receiver. Long range receivers shall be mounted on the exterior face of the building with unobstructed view and reception width within the required range, including after apparatus turn onto the street. Refer to Architectural Drawings for mounting locations. Coordinate requirements for conduit and mounting with electrician.

4. A Time-to-Close function shall be included that is programmable from 1 minute to 30 minutes, in not less than 1-minute increments. The time-to-close function shall be temporarily disabled when the stop button is pressed from any of that door's 3-button controllers after the door is fully opened, until the next time a close button is pressed.

5. The control system shall be operable by internet connection, and by free downloadable application via hand-held device. The application shall indicate whether the position of the doors is fully closed or not. Coordinate exact requirements of this system with Owner during installation.

1.04 SUBMITTALS

A. Product Data for each type of product specified, including installation instructions and data substantiating that products comply with requirements.

B. Submit detailed shop drawings of all work, including the location of each door. Clearly show and describe in detail, detailed door assemblies and adjacent construction, including elevations, sections and details of hardware, operating components, dimensions, finishes and relationship of door, frames, hardware and operating components to adjacent construction.

C. Installer's qualifications.

1.05 CLOSEOUT SUBMITTALS

A. Submit copies of operating and maintenance data, for inclusion in maintenance manuals. Include schedule of all routine maintenance required as stipulated by warranties.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Installation work shall only be carried out by the door manufacturer or by an approved installation company properly licensed or franchised by the Manufacturer for installation work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standards and manufacturer's written instructions. Store delivered materials and equipment in dry locations with adequate ventilation and protected for dust and water.

B. Handle materials carefully to prevent damage.

1.08 WARRANTY

A. Door Manufacturer shall provide Owner a written guarantee, warranting the door against any defects of materials and/or workmanship for the new door for a period not less than two (2) years, with proper maintenance commencing from the date of a substantial completion of the project. Motors shall be guaranteed for a period of (1) one year. Manufacturer shall repair or replace defective materials during warranty period at no cost to Owner.

B. Door Installer shall provide written guarantee, warranting the door installation against defects in installation of workmanship for a period of two years from the date of substantial completion. Installer shall make all repairs required due to faulty installation, as required to restore doors and controls to perfect operating condition and to repair damage caused by faulty installation, at no cost to Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Design for four-fold doors are based on products as manufactured by Door Engineering and Manufacturing, LLC, 400 Cherry Street, Kasota, MN 56050, (800) 959-1352. Subject to compliance with requirements, provide the named products or approved comparable products by another Manufacturer.

2.02 MATERIALS AND FABRICATION

A. Structural Steel: ASTM A36/A36M.

B. Steel Sheets: Steel sheets of commercial quality, complying with ASTM A366/A366M cold-rolled steel sheet, or A569/A569M hot-rolled steel sheet.

C. Hardware: Manufacturer’s standard components.

D. Fasteners: Zinc-coated steel.

2.03 FOUR-FOLD DOORS

A. Basis of Design: The drawings and specifications are based on “FF300 Series”, glazed four-fold doors, as manufactured by Door Engineering and Manufacturing, LLC.

B. Construction: Door framing of minimum 14 gauge structural steel tube with minimum 14 gauge steel sheet on the exterior and interior faces. Sheeting shall be formed on the vertical edges with no visible welds on the interior or exterior panel faces. All frames and framing members shall be true to dimension and square in all directions, and no door shall be bowed, warped, or out of line, in the vertical or horizontal plane of the door opening by more than 1/8 inch in 20 feet. Exposed welds ground smooth and flush. Doors fully foam insulated.

C. Surface Mounted Tube Frame: Supply pre-hung tube frame system constructed of TS6x4x0.25, designed to anchor to masonry wall construction or weld to steel structure. All hinges, track supports, and operator supports shall be factory attached.

D. Door Finish: Factory applied exterior grade powdercoat, custom color as selected by Architect.

E. Operating Hardware: Hardware shall include guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening, and all bolts, nuts, fasteners, etc. as necessary for complete installation and operation. Jamb hinges shall be dual shear and have two thrust bearings and two needle bearings. Jamb hinges shall be gusseted. Fold hinges shall be dual shear with two thrust bearings. All bearings shall be completely concealed within the hinge barrel. All hinge pins shall be minimum 3/4" diameter hardened steel.

F. Weather Stripping: Material shall be adjustable, readily replaceable and provide a substantially weather-tight installation.

G. Vision Panels: Provide 1” tinted, insulated, tempered glazing, of size as shown on the Drawings.

2.04 OPERATOR

A. Basis of Design: Provide operators, door engineering and manufacturing as described in this paragraph, or approved equal by another manufacturer.

B. Each Four-Fold door shall be operated by an overhead mounted electro-mechanical drive unit designed for high cycle operation. Operator consists of an electric motor, gear reducer, and rotating drive arm. The door shall be operated with connecting rods attached to the rotating drive arm on the operator and to control arms attached to the jamb door section and to the door lintel. The connecting rods shall be positive drive, keeping the door under firm control at all times. The connecting rods shall be fitted with spherical bearings and control arms shall be equipped with oil impregnated bronze bearings on polished shafts.

C. Operator shall be instantly reversible, open and close rapidly and start and stop gradually. Operator shall be adjustable to allow door to fully clear the opening. Operator shall automatically lock the door in the closed position. Operator shall be equipped with disengaging mechanism to convert to freewheeling mode for manual operation.

D. Electric motor shall be of sufficient size to operate doors under normal operating conditions at no more than 75 percent of rated capacity. The motor shall be wound for three phase 208/260/480 VAC, 60 Hertz operation.

E. Electric Controls: Controls shall be furnished by the door manufacturer and shall be complete for each door and built in accordance with the latest NEMA standards. Control circuits shall not exceed a nominal 110 volts.

1. Controls shall include a programmable logic controller with digital message display. Controller shall include programmable close timers and programmable inputs/outputs.

2. Motor starters shall be magnetic reversing, factory wired with overload and under voltage protection and equipped with mechanical interlocks. All control components shall be enclosed in one enclosure with a wiring diagram placed on the inside of the cover.

3. Enclosures shall be NEMA 4 with disconnect switch.

4. Pushbuttons (interior) for each door shall have one momentary pressure three-button, push-button station marked “OPEN”, “CLOSE” and “STOP”. Push button enclosure shall be NEMA 4.

5. Limit switches shall be provided to stop the travel of the door in its fully open or fully closed position. Provide auxiliary limit switch to be used for HVAC or exhaust removal system.

6. Safety edges: Provide electric safety edges on leading edge of all doors to reverse door upon contact with obstruction. Provide wireless safety edge transmitters with low battery alarm.

7. Photo eyes: Provide interior and exterior thru-beam type photo eyes, NEMA 4 rated.

a. Safety Photo Eye - Doors shall have (1) set of through beam photo eyes on the outside of the door opening set at 18” A.F.G. for the transmitter and 48” A.F.G. for the receiver. The photo eye will disable the close cycle until the transmitted beam is clear and will reverse the door and return the door the full open position if the transmitted beam is interrupted during the close cycle.

b. Safety Sensor (Open / Close) – Each four-fold door shall have (1) combination presence and motion sensor to protect the full path of the door for both opening and closing directions. The sensor shall be BEA “LZR Widescan”, installed above the door opening on appropriate mounting supports and bracket as required to properly position the scanner for the operation indicated. The sensor will use 2 scan zones to operate as follows:

i. Zone 1: Zone 1 is a combination presence and motion sensor zone scanned for pre-activation of the motor including the full path of the doors. The zone shall include the rectangular area of the door swings between the fully open to fully closed positions as well as the space between the door swings, and also shall be adjusted to include up to 3 feet beyond the fully open position of the doors to either side to within an inch of any side obstructions (or including a minimum of 16” and up to the full 3’-0” beyond the open position of the doors if there are no such obstructions). Where there is not a side obstruction between adjacent four-fold doors, the zone 1 areas of adjacent doors shall overlap to ensure that continuous safety protection is provided. Zone 1 shall scan prior to operation of the doors to ensure an obstruction is not present prior to door operation, and shall prevent operation to open or close upon detection of an obstruction.

ii. Zone 2: Zone 2 is motion sensor zone monitored continuously prior to and during motion (opening or closing). The zone includes a narrow rectangular zone approximately 4" in depth and immediately adjacent to zone 1 just outside of the swing of the four-fold doors. The width of zone 2 shall adjusted to not less than the overall width of zone 1, or to a width as required to ensure that person, vehicle, or other obstructions do not enter zone 1 after the doors are set in motion. Where there is not a side obstruction between adjacent four-fold doors, the zone 2 areas of adjacent doors shall overlap to ensure that continuous safety protection is provided. Activation of the zone 2 motion field shall stop the door.

iii. After the obstruction is removed, operation can resume through any normal activation of the doors as specified such as by pushbuttons or by radio controls. Field verify sensor mounting locations and clearances with owner.

8. Radio controls: Provide one (1) radio receiver and two (2) two button remotes per door. Remotes to open and close doors with single button.

9. Wiring: Door manufacturer shall supply controls only. Contractor shall coordinate interlocking of controls with security grilles as described in Part 1-"Performance Requirements", and shall install controls and furnish and install conduits, relays, wiring, etc. as required for jobsite power and control wiring.

2.05 DOOR CONTROL SYSTEM

A. Control Panel shall be UL 508-A in a NEMA TYPE 12 enclosure with a fusible disconnect, 208/240/480/120 control transformer with primary fusing. This system shall be variable speed driven, relay logic with a selector switch for manual or automatic operation of the door when required. Components shall be an integral part of the panel and mounted to enable replacement. All wiring shall be neatly grouped and placed in wire duct in a neat and workmanship like manner and wired to a coded terminal strip.

B. Pushbutton Station - Doors shall have a NEMA TYPE 12 three unit "Open"-"Close"-"Stop" pushbutton station installed on the inside of the building. Location to be determined by the owner adjacent to each door, and master button for all four-fold doors at the air lock vestibule(s) determined by Owner.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install Four-Fold metal doors in strict accordance with the approved drawings by qualified door erection crews. All door openings shall be completely prepared by the Contractor prior to the installation of the doors. Permanent electric wiring shall be brought to the door opening before installation is started and shall be completed so as not to delay the inspection test.

B. Install doors, guides, steel supports, operating hardware and electric controls. Provide required fastening devices, hangers, bolts, etc.

1. Install units to fit into jambs and head of frames and ensure smooth operation under all conditions of operation.

C. Doors shall be set plumb, level, and square with all parts properly fastened and mounted. All moving parts shall be tested, adjusted and left in perfect operating condition.

3.02 ADJUSTING AND CLEANING

A. Inspection of the doors and a complete operating test will be made by the installer in the presence of the General Contractor and owner as soon as the erection is complete. Any defects noted shall be corrected. The General Contractor shall be responsible to protect the doors from any damage or rough handling for the remainder of the construction period until the building is turned over to the owner and final inspection is made.

B. Clean surfaces and repaint abraded or damaged finished surfaces to match factory-applied finish.

3.03 DEMONSTRATION

A. Test and operate doors and demonstrate the operation of same to satisfaction of Owner at time of acceptance of completed work. Train owner in user-programable and safety features of the doors.

END OF SECTION 08 35 13

SECTION 08 36 13 - UPWARD ACTING SECTIONAL DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide Upward Acting Sectional Door assemblies including brackets, guides, tracks, hardware, operators and installation accessories.

B. Related Sections include the following:
   1. Division 04 Section "Unit Masonry Assemblies."
   2. Division 05 Section "Structural Steel Framing", for miscellaneous steel at perimeter of openings for attaching overhead doors.
   3. Division 06 Section "Wood Framing" for wall framing above sectional door heads.
   4. Division 08 Section "Aluminum Storefronts and Entrances.", for coordination of door color with aluminum storefronts.
   5. Division 08 Section "Door Hardware."
   6. Division 08 Section "Glazing."
   7. Division 09 Section "Painting."
   8. Division 26 Section "Electrical."

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall be a Manufacturer-authorized distributor / installer for the doors as specified, with minimum 5 years continuous operation under the same company name, and able to demonstrate a record of successful in-service performance of installed doors of the same type as specified.

B. Certifications: From Installer, that the installed doors will meet air infiltration requirements as required by local code, or as herein specified, whichever is more stringent.

C. Doors Design Criteria: Door system designed to withstand external or internal wind loads of 20 psf, and also wind loading as required per local code requirements, whichever is greater. Maximum deflection shall not exceed l/120 of the span.
   1. Design and install doors and seals to perimeter construction as required to prevent air leakage to meet or exceed local code requirements and IECC 2015: 0.40 CFM/ft^2 or less, per ANSI/DASMA 105, NFRC 400, or ASTM E 283 at 1.57 psf.

D. Controls Design Criteria for Fire Station Apparatus Bays: Design and provide complete controls for Sectional Doors to operate as described, whether or not specified control units can perform the described operation without modifications. Specified control units are to establish quality and performance criteria, and does not guarantee that this sequence of operation can be achieved without other external controls and interface:
   1. Four fold doors shall be controlled individually by 3-button controls at the following locations (refer to Electrical drawings):
      a. At the jamb adjacent to each opening.
      b. At both air locks.

c. Additionally, all front bay doors shall be controlled to all open by single press of a red mushroom button located in each air lock.

2. Sectional doors shall be capable of receiving control input to open and close from the station alerting system.

3. Sectional doors shall be controlled individually by radio frequency controls, and as follows:

   a. Doors shall be controlled such that each bay works with the Fire Department's existing universal transmitters that are used for all of their Fire Stations. Contractor is responsible to coordinate requirements for this operation with the Fire Department, and to fully test each opening. Provide supplementary receivers where required to match required frequency and codes.

   b. Provide a supplementary long-range receiver (with minimum of 300 ft range) for each door on the rear exit side of the apparatus bays. This receiver is in addition to the interior receiver. Long range receivers shall be mounted on the exterior face of the building with unobstructed view and reception width within the required range, including after apparatus turn onto the street. Refer to Architectural Drawings for mounting locations. Coordinate requirements for conduit and mounting with electrician.

4. A Time-to-Close function shall be included that is programmable from 1 minute to 30 minutes, in not less than 1-minute increments. The time-to-close function shall be temporarily disabled when the stop button is pressed from any of that door's 3-button controllers after the door is fully opened, until the next time a close button is pressed.

5. The control system shall be operable by internet connection, and by free downloadable application via hand-held device. The application shall indicate whether the position of the doors is fully closed or not. oordinate exact requirements of this system with Owner during installation.

6. For the Workout Room sectional overhead door, provide a heavy duty 3-button controller at the door leading from the corridor inside the room, and at the section door near the jamb (verify exact mounting locations with Owner).
   a. Provide (3) – 3-button transmitters for this sectional door.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and color selection chart.

B. Shop drawings and details based on the Contract Documents shall be submitted to the Architect for review prior to ordering of materials.

C. Delegated Design Submittal:
   1. Controls: Construction Manager's certification, and controls wiring and schematics by Construction Manager's designated responsible party(ies) as required, achieving the sequence of operation as specified.

D. Informational Submittals:
   1. Qualifications, for Installer.
   2. Certifications.

1.05 PROJECT CONDITIONS

A. Coordinate shop drawings and installation of overhead doors with other mechanical equipment, plumbing, and lighting in the apparatus bay. Inform architect of any conflicts. Doors and tracks shall be designed and installed to turn horizontal as high as possible. Lighting located above doors should be located to shine through glass panels in the doors. Coordinate with other trades to run wiring inside conduit horizontally above bay doors, and concealed behind CMU block or in stud wall cavities vertically to the maximum extent possible.

B. Install door to seal to perimeter construction as required to prevent air leakage in excess of local code requirements.

C. Provide all bracing and supports for tracks as required for complete installation.

1.06 WARRANTIES

A. Door Manufacturers' standard warranties.
   1. Include door manufacturer's 3-Year / 20,000 cycle Warranty on door.
   2. Standard warranties for finishes specified:
      a. Anodized Finish: 5 years.
      b. Painted Finish 10 years.

B. Operator Manufacturer’s standard 2 year limited warranty against material and manufacturing defects.

C. Installer’s Warranty: Installation shall be waranteed by installer for a period of two years against defects in materials and workmanship.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Sectional Doors: Basis of Design: Design for overhead doors is based on products as manufactured by Overhead Door Company. Subject to compliance with requirements, provide the specified products or approved equal.

B. Operators: Provide Liftmaster operators as specified, or approved equal product.

C. Source Limitations:
   1. Obtain section overhead doors, and related hardware and other accessories from a single manufacturer.
   2. Obtain all operators, controls, and related hardware and other accessories from a single manufacturer.

2.02 MATERIALS

A. Upward Acting Sectional Doors: Prefinished, aluminum with glazing, Aluminum Model 521 as manufactured by Overhead Door Corporation.
   1. Track: 3”, high lift.
      a. Unless otherwise indicated, also provide all miscellaneous steel fabrications as required for complete, secure, and rigid attachment and support of tracks as required to provide for smooth, trouble-free operation of the door system.
      b. Where required by wall construction, provide ¼” bent plates to comply with Division 05 Section “Metal Fabrications” for connection of tracks to adjacent steel or 8” or larger size CMU structure. Do not support tracks from masonry veneers or other finish materials.

2. Door Assembly: 6063-T6 Aluminum stiles and rails.
    a. Panel Thickness: 1 ¾”
    b. Top and Bottom Rail Width: 3-3/4”
    c. Aluminum Panels: 0.050 aluminum, finish to match rails and stiles. Aluminum panels in color to match door frame finish.
    d. Glazing: ¼” tinted tempered glass.
3. Weatherseals: Bottom, flexible PVC. Side and top gaskets as required to seal against air leakage in compliance with local code requirements.
    a. EPDM bulb-type strip at bottom section.
    b. Flexible Jamb seals.
    c. Flexible Header seal.
4. Finish: Kynar coated, in custom color to match aluminum storefront.
5. All exposed fasteners, anchors, hardware or attachments shall be galvanized, cadminum-plated or stainless steel.
6. Heavy-duty higher-cycle springs for 50,000 cycle rating.

B. Industrial-Duty Operator: LiftMaster Industrial-Duty Hoist Operators, continuous-duty, high-starting torque motor with overload protection and an emergency chain hoist with electric interlock:
    1. Model: LiftMaster H
    2. Electric Operator: Industrial-duty assembly, cULus listed and cULus labeled, with electric motor and factory-prewired motor controls, manually operated chain hoist, 3-button open/close/stop control station, conduit-encased wiring from control circuit to motor, positive locking mechanical system acting as a holding brake, and accessories required for proper operation; door speed of approximately 8 to 9 inches (203 to 229 mm) per second
        a. Drive Reduction: Heavy-duty 5L V-belt primary reduction and chain/sprocket secondary and third stage reduction; all reduction sprockets and pulleys shall be drilled and pinned to steel shafts plated for resistance to corrosion; operator shall be equipped with permanently lubricated ball bearings on output shaft, adjustable friction clutch and output and door driven sprockets.
        b. Brake: Electric solenoid-actuated brake that is capable of stopping and holding a door at any position.
        c. Limit Switches: Fully adjustable, linear-driven limit mechanism synchronizing operator with door; low-friction nylon limit nuts fitted on treaded steel shaft that rotates on oil-tight self-lubricating bronze bushings; motor shall be removable without affecting limit switch settings.
        d. Electric Motor: High-starting torque, continuous-duty, industrial-type protected against overload by current sensing and thermal overload devices.
            1) 1 hp motor
            2) 115 VAC operation.
        e. Motor Control and Enclosure: LiftMaster Logic 5.0 motor control shall be UL-approved microprocessor solid-state type and shall include the capability to select one of 7 wiring types; additional features shall include a maintenance alert diagnostic system, programmable Timer-to-Close with timer defeat input, mid-stop programming capabilities and a maximum run timer to provide motor overrun protection; motor control shall be housed in a NEMA 1 enclosure integral to the operator and shall conform to ANSI/NEMA ICS 6.
            1) Radio Receiver: LiftMaster Logic 5.0 on-board, 3-channel receiver with standard external antenna; equipped to accept Security+ 2.0 Rolling Code Technology remote controls and trinary DIP switch remote controls, with

memory up to (30) 3-button remote controls, plus 30 wireless keypads, or an unlimited number of trinary DIP switch remote controls. Tri-band frequency (310/315/390 MHz) sends multiple radio signals to bypass radio interference.

2) Internet Connectivity: MyQ Technology.
   a) 902 to 928 MHz.
   b) 50-channel FHSS (Frequency Hopping Spread Spectrum).
   c) LiftMaster 828LM Internet Gateway enables monitoring and control of door operators and lighting controls via Internet-enabled smartphone, tablet or computer.
   d) Provides two-way communication between commercial door operator and MyQ Accessories to enable remote open, close and monitoring of commercial door.

f. 3-Push-button operated control stations: Heavy Duty, flush-mount type with open, close, and stop buttons for interior wall mounting inside recessed electrical box in wall shall be NEMA Type 1 with maintenance alert indicator to signal intervals for routine door and operator maintenance. Provide number and locations as indicated on drawings.
   1) Where installed in banks of buttons, electrician shall verify exact mounting requirements with Owner's representative in the field.

g. Safety Equipment:
   1) NEMA 4X Monitored Photo Sensors: LiftMaster CPS-OPEN4 Monitored Photo Eyes (commercial thru-beam) and CPS-RPEN4 Monitored Retro-reflective Photo Eyes, fully monitored, non-contact, photo beam reversing photo sensor system with NEMA 4X watertight/corrosion-resistant enclosure shall reverse, in conjunction with the operator, a closing door to the full open position when an obstruction is sensed; photo sensors shall be mounted no higher than 6 inches maximum above the floor.
      a) Provide a second set of beam sensors per opening at 3'-0" or other elevation as directed by the Fire Department, to detect interference of high clearance to ground apparatus such as fire engines and ladder trucks. Confirm desired mounting elevations for each opening with Fire Department representative in field.
   2) NEMA 6 Monitored Optical Edge System (OES): Shall provide a means to attach a 2-wire monitored sensing edge to a LiftMaster Logic 5.0 operator for continuous monitoring purposes; the edge, in conjunction with operators, shall reverse a closing door to the full open position when an obstruction is sensed; sensing edge ordered separately and can be field-cut to required length.

h. Enhanced Receiver / Transmitter Options:
   1) Enhanced universal receiver at interior operator, LiftMaster 850LM, with 813LM 3-button enhanced remote controllers.
   2) Additional Remotes: Provide a total of 3 controllers per opening.

3. Manual Override Operation: Chain Hoist.
4. Lock: Operator does not allow manual operation except by manual chain override.

C. Upward Acting Sectional Doors at Workout Room: Prefinished, aluminum with glazing, polyurethane insulated rails and stiles (R-4.1) Aluminum Model 521 as manufactured by Overhead Door Corporation.
   1. Air Infiltration: 0.08 cfm @ 15 mph.
   2. 2" galvanized minimum 16 ga. tracks attached to opening per manufacturer's standard recommendations. Vertical track to provide weathertight closing with bracket. Horizontal tracks reinforced adequately to prevent deflection.

a. Where required by wall construction, provide ¼" bent plates for connection of tracks to structure, to comply with Division 05 Section "Metal Fabrications". Do not attach tracks to masonry veneer.

3. Looped vinyl weatherstripping at door bottom.
4. Counter-balance: Torsion-type springs, low stress, helical-wound spring wire rated for 25,000 cycles of use. Spring fittings and drums of die cast high strength aluminum. Torsion spring equipment on doors shall be accommodated by easy manual operation
5. Finish: Kynar coated, in custom color to match aluminum storefront.
6. All exposed fasteners, anchors, hardware or attachments shall be galvanized, cadminum-plated or stainless steel.

D. Medium-Duty Operator: LiftMaster MH Medium-Duty Logic Hoist Operator, limited-duty (recommended duty of 12 cycles per hour), high-starting torque motor with overload protection and emergency chain hoist with electric interlock.
   1. Electric motor Model MH – Electric Operator: Medium-duty assembly for high lift sectional doors, cULus listed and cULus labeled, with electric motor and factory-prewired motor controls, emergency floor-level manual chain hoist mechanism with electrical interlock, electric solenoid-actuated brake, 3-button open/close/stop control station, conduit-encased wiring from control circuit to motor, and accessories required for proper operation; operator shall provide a door speed of approximately 8 to 9 inches (203 to 229 mm)per second.
      a. Primary Speed Reduction: Heavy-duty 4L V-belt and #41 chain and sprocket with sprocket reduced secondary; operator shall be equipped with adjustable friction clutch and output and door driven sprockets.
      b. Brake: Electric solenoid-actuated brake capable of stopping and holding a door at any position.
      c. Limit Switches: Fully adjustable, linear-driven limit mechanism synchronizing operator with door; low-friction nylon limit nuts fitted on threaded steel shaft that rotates on oil-tight self-lubricating bronze bushings; motor shall be removable without affecting limit switch settings
      d. Electric Motor: High-starting torque, 115V, single-phase, 1/2 HP motor with an internal automatic reset thermal overload device to protect against overload.
      e. Motor Control and Enclosure: LiftMaster medium-duty Logic motor control shall be a microprocessor solid-state type PCB; the control board shall provide the capability to select one of 2 wiring types, diagnostic LEDs for operator status and troubleshooting, programmable Timer-to-Close with timer defeat capabilities and a maximum run timer to provide motor overrun protection; motor control shall be housed in a NEMA 1 enclosure integral to the operator and shall conform to ANSI/NEMA ICS 6.
         1) Radio Receiver: LiftMaster medium duty Logic on-board, 3-channel receiver with standard external antenna; equipped to accept Security+ Rolling Code Technology remote controls and trinary DIP switch remote controls, with memory up to (20) Security+ remote controls, or an unlimited number of trinary DIP switch remote controls.
      f. 3-Push-button operated control stations: Heavy Duty, flush-mount type with open, close, and stop buttons for interior wall mounting inside recessed electrical box in wall, shall be NEMA Type 1 with maintenance alert indicator to signal intervals for one bank in location as indicated on drawings.
      g. Door Drive: Full #41 roller chain with emergency disconnect for manual door operation.
      h. Safety Equipment:

1) Monitored, photoelectric safety beam sensor, designed to prevent doors from activating to close, or if already in motion to signal the door operator to reverse to open, if there is an obstruction sensed. Door shall be allowed to open regardless of obstruction.
2) Ancillary Protection Devices:
   a) Sensing Edge: A "non-contact" photoelectric safety edge sensor designed to sense an obstruction below the door and signal the door operator to reverse to open.
   b) Motion Detector: Exterior mounted, motion sensing device, mounted at exterior wall above the center of the door, designed to reverse door to open if and approaching vehicle is detected while the door is closing, Liftmaster 50-HERK-RC2, or approved equal.

i. Manual override operation: Hand pull chain
j. Locks: Operator does not allow manual operation of door except by chain override.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until openings have been properly prepared.

B. Verify wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

C. Verify electric power is available and of correct characteristics.

D. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install overhead doors and track in accordance with approved shop drawings and the manufacturer's printed instructions.

B. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

C. Anchor assembly to wall construction and building framing without distortion or stress.

D. Overhead door shall be mounted to inside face of wall with tracks braced to ceiling in accordance with manufacturer's recommendations for a track installation. Securely support and brace door tracks suspended from structure. Secure tracks to structural members only. Door, when installed, shall fit flush, tight and level to floor construction with side jambs properly plumbed and supported to meet design criteria. Provide all accessory brackets and shims as may be necessary for a complete installation.

3.04 ADJUSTING AND CLEANING

A. Completed door shall have all mechanisms properly adjusted and lubricated. Unit set tight to wall and weatherstips installed to properly close off opening.

1. Doors shall open and close smoothly, without jerks or binding, and without excessive vibration or lateral movements while in motion that could shorten the operating life of the door or operator.
2. **[Set Fire Department time to close pre-set to disable time to close function. Confirm time to close pre-set desired with Police Department representative and set door controls accordingly] [Confirm time to close pre-set desired with Fire Department representative and set door controls accordingly. Include reset of timer programming in Owner training]**.

B. Clean doors in accordance with Manufacturer' instructions, using materials and methods that will not damage parts of finishes.

C. Protect installed doors until project completion.

3.05 TESTING, DEMONSTRATION AND TRAINING

A. Fully test operation of the doors prior to owner demonstration and training. Demonstrate operation to Owner's satisfaction during Owner demonstration and training. Testing shall include but is not necessarily limited to the following:
1. Test and demonstrate each door for smooth operation.
   a. If each door does not operate smoothly, make required adjustements and repeat demonstration for those doors after corrections are made.
2. Test and demonstrate radio control reception to the required distance for each receiver and door.
   a. In the event that reception is unsatisfactory, make required adjustements and repeat demonstration for those doors after corrections are made.
3. Test door safety devices for proper function. Make adjustments as required.
4. Test other controls and control interlocks for proper function, as applicable.
5. Test that operating all doors simultaneously does not trip breakers.

B. Conduct training of Owner's personnel in compliance with Division 01, Section "Demonstration and Training".
1. Include time-to-close programming and other programmable functions in Owner training.
2. **[If handheld or remote device (smart phone, computer, etc.) control of doors is applicable, demonstrate installation of software applications to devices and test control functions from the remote device]**.

END OF SECTION 08 36 13

SECTION 08 41 13 - ALUMINUM ENTRANCES & STOREFRONT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide storefront (including aluminum doors and hardware), framing complete with glazing as shown on the drawings and as herein specified.

B. Related Sections:
   1. Division 05 Section - "Metal Fabrications".
   2. Division 06 Section - "Rough Carpentry".
   3. Division 07 Section - "Thermal Insulation".
   4. Division 07 Section – "Modified Bituminous Sheet Air Barriers"
   5. Division 07 Section - "Sheet Metal Flashing and Trim".
   6. Division 07 Section - "Joint Sealants".
   7. Division 07 Section - "Firestopping".
   8. Division 08 Section - "Door Hardware".
   9. Division 08 Section - "Glazing".
   10. Division 12 Section - "Window Treatments".

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Glass breakage.
      e. Noise or vibration created by wind and by thermal and structural movements.
      f. Loosening or weakening of fasteners, attachments, and other components.
      g. Sealant failure.
      h. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated in structural drawings and ass required by authorities having jurisdiction.

D. Deflection of Framing Members:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.
      a. Operable Units: Provide a minimum 1/16 inch clearance between framing members and operable units.

E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

F. Air Infiltration:
   1. Fixed Framing: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 psf.
   2. Entrance Doors: Maximum air leakage of 1.0 cfm/sq. ft. for pair of doors, and maximum of 0.5 cfm/sq. ft. for a single door, at a static air pressure differential of 6.24 psf.

G. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 8 psf.

H. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.36 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
   2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.

I. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
   2. Interior Ambient-Air Temperature: 75 deg F.

J. Brake Metal: Provide in thicknesses as required to prevent oil canning, including for exterior brake metal oil canning that may be caused by design wind loads. Additionally, thickness may be greater but shall not be less than minimum thicknesses as specified elsewhere in these specifications, or minimum thicknesses as indicated in Drawings. Contractor shall include necessary thicknesses in his bid.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Shop drawings and details based on the Contract Documents submitted to the Architect for review. Include plans, elevations, sections, full-size details, and attachments to other work. Show connection to and continuity with adjacent thermal, weather, and air barriers.

D. Samples for initial Selection: Manufacturer's standard color selector sheets or factory applied selector plates. Website or print media other than Manufacturer's provided materials do not represent accurate color renditions and are not acceptable.

E. Samples for verification:
   1. Submit three samples of each required aluminum finish on aluminum plates or extrusions.

F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, door hardware, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware. Submit for concurrent review with other door and hardware submittals, and coordinate with Owner's Access Control supplier/installer.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
   1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront. Compliant with local code requirements and as specified herein, whichever is more stringent.

C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency, or by a qualified testing agency.

D. Sample Warranties: For special warranties.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

1.07 QUALITY ASSURANCE

A. Fabricator and Installer: Shall have a minimum of 5 years experience on projects of similar size and scope. Installer shall be approved by Manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate typical construction and waterproofing details, and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Incorporate fixed storefront framing with glazing as part of mockup panels as detailed in Drawings, and as described elsewhere in Specifications.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Packing, Shipping, Handling, and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle material and components to avoid damage. Protect curtain wall material against damage from elements, construction activities, and other hazards before, during and after curtain wall installation.

1.09 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 GUARANTEE AND WARRANTY

A. Installer shall submit a written guarantee to the Owner, guaranteeing storefront system for a period of 2 years against leaks and defects in the system.

B. Door manufacturer's warranty shall provide for a period of 10 years from date of Substantial Completion. All hardware installed by manufacturer shall be covered by warranty.

C. Manufacturer's Finish Warranty: Manufacturer's standard limited warranty against fade, chalk, crack, check, peel, and failure of coatings to adhere to metal. Warranty duration as follows:
   1. Anodic Finish: 10 years from date of delivery.
   2. Fluropolymer Finish: 20 years from date of delivery.

1.11 MAINTENANCE MATERIALS

A. Entrance Door Hardware:
   1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Exterior Storefont basis-of-design product: 1-3/4"" x 4-1/2" storefront glazing system, thermally broken at exterior. Subject to compliance with requirements, provide EnCore™ system as manufactured by Kawneer Company, or approved equal. Exterior fixed storefront shall have two color capability (exterior finish separate from interior finish).

B. Interior Storefront: 1 3/4" x 4” storefront glazing system, center plane glass, non-thermal. Subject to compliance with requirements, provide Trifab 400 system as manufactured by Kawneer Company, or comparable product by one of the following:
   1. Oldcastle Building Envelope.
   2. Tubelite Company, Inc.

2.02 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   1. Sheet and Plate: ASTM B 209.

2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.03 FRAMING SYSTEMS

A. Framing Members and Brake Metal Fillers: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken at exterior framing, non-thermal broken at building interior.
2. Glazing Plane: Center.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from stainless steel.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

G. Thermal Barrier: A minimum 1/4” separation between the interior and exterior aluminum created by intermittent polymer clips.

2.04 GLAZING SYSTEMS

A. Glazing: As specified in Division 8 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.05 OPERABLE ALUMINUM WINDOWS

A. Aluminum Windows: Subject to compliance with requirements, provide OptiQ™ AA 5450 Series by Kawneer, or comparable product by another approved manufacturer, complying

with AAMA/WDMA/CSA 101/I.S.2/A440, with self-flashing mounting fins, interior and exterior dual finish options, and as follows:

1. Window Type: Single hung.
2. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 0.070-inch thickness at any location for main frame and sash members.
    a. Thermally Improved Construction: Fabricate window units with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
3. Muntins: Applied exterior with finish to match and applied interior with finish to match, attached as recommended by manufacturer.
4. Fasteners, Anchors, and Clips: Nonmagnetic stainless steel, aluminum, or other noncorrosive material, compatible with aluminum window members, trim, hardware, anchors, and other components of window units. Fasteners shall not be exposed, except for attaching hardware.
    a. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.128 inch thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, spline grommet nuts.
5. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
    a. Cam-action sweep sash lock and keeper at meeting rails.
    b. Spring-loaded, snap-type lock at jambs.
    c. Lift handles for single-hung units.
    d. Cam handle locks.
    e. Nylon sash rollers for horizontal-sliding units.
    f. Pole-operated, cam-action locking device on meeting rail where rail is more than 72 inches above floor.
    g. Steel or bronze operating arms.
6. Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric; complying with AAMA 701/702.
7. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:
    a. Aluminum Wire Fabric: 18-by-18, 18-by-16, or 18-by-14 mesh of 0.013-inch-diameter, coated aluminum wire.

B. Finish:

1. Exterior Side: Kynar 500 / Hylar 5000 finish, custom exterior finish as selected by Architect.
2. Interior Side: Clear AA-M12C22A31/A32/A34, AAMA 611, Architectural Class I Clear Anodic Coating.

2.06 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

1. Door Construction: Minimum of 1-3/4-inch overall thickness, with minimum 0.125-inch thick, extruded-aluminum tubular rail and stile members, with glazing pockets sized for specified insulated glazing. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
2. Door Design: Wide stile; 5-inch nominal width.

3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
    a. Provide nonremovable glazing stops on outside of door.

B. Entrance Door Hardware: Factory install entrance door hardware provided by Manufacturer to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes
    1. Weather-stripping / gasketing: Manufacturer's standard replacement stripping of molded neoprene gaskets complying with ASTM D-2000. At exterior doors, provide compression weather stripping. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
    2. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
    3. At double doors specified to receive removeable mullions, provide filler blocks as required for complete support above removable mullion top brackets.
    4. Refer to Division 08, Section "Door Hardware" for more information.
    5. Reinforce doors as required for installing entrance door hardware.

2.07 ACCESSORY MATERIALS

A. Aluminum Trim: Provide brake metal trim in locations specifically shown in Drawings and other locations as required for complete installation. Thicknesses indicated in Drawings and specifications are minimum thicknesses regardless of minimum thickness to prevent oil canning. Provide greater thickness than indicated minimum thicknesses where required to prevent oil canning. Contractor is responsible to determine required thicknesses per delegated design requirements (refer to Part 1 of these specifications). Finish to match adjacent storefront system(s).

B. Anchoring Devices: Provide plates, angles, steel frame bracing, wind bracing, spacers, clips and other devices necessary to support aluminum framing and glass. Design of connections shall be fabricator's responsibility. Submit shop drawing for approval.

C. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 7 Section "Joint Sealants."
    1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

E. Security Screens: Refer to Division 08, Section "Security Screens".

2.08 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
    1. Profiles that are sharp, straight, and free of defects or deformations.

2. Profiles with solid back extrusions, or with filler plates, as required to receive membrane flashings at jamb flashings (locations where metal jamb flashing is not otherwise indicated).
3. Accurately fitted joints with ends coped or mitered.
4. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
5. Physical and thermal isolation of glazing from framing members.
6. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
7. Provisions for field replacement of glazing from exterior.
8. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.09 ALUMINUM FINISHES

A. At Interior Side of Fixed Storefront and Operable Aluminum Windows: Clear Anodic Finish: AA-M12C22A31/A32/A34, AAMA 611, Architectural Class I Clear Anodic Coating. Class II for interior storefront.
1. Color: Clear anodized.

B. At Exterior Side of Exterior Fixed Storefront and Operable Aluminum Windows: Kynar 500 / Hylar 5000 finish / In-House Spray Applied Flouropolymer 4 Coat 70% PVDF conforming to AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color: Custom color as selected by Architect.

C. Miscellaneous Steel Bracing (Concealed): One (1) shop coat of red oxide primer.

D. Source Quality Control: Representative samples of color anodized finish shall meet or exceed following tests: ASTM B224, thickness of coating; and ASTM B117, neutral salt spray.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 7 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 8 Section "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
   1. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install perimeter joint sealants as specified in Division 7 Section "Joint Sealants" to produce weathertight installation.

I. Prepare windows for installation of security screen.

3.03 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
   1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
   2. Alignment:
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
      b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

3.04 ADJUSTING

A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
   1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.

3.05 PROTECTION AND CLEANING

A. Protect aluminum framing and/or doors during construction by masking members with approved cardboard and paper as recommended by manufacturer. Take particular care in protecting openings and doors from damage during construction.

B. Upon completion, remove trimmings and other debris. Replace broken, scratched, chipped or other damaged glazing. Remove excessive sealant, mastic and other marks from adjacent surfaces, and wash with clean water. Cleaning of glazing must be done in strict compliance with manufacturer's recommendations.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during the construction period.

END OF SECTION 08 41 13

SECTION 08 70 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Door hardware, including electric hardware.
2. Storefront and entrance door hardware.
3. Gate Hardware.
4. Power supplies for electric hardware.
5. Door position switches.
6. Cylinders for doors fabricated with locking hardware.

B. Related Divisions:

1. Division 06 – door hardware installation
2. Division 07 – sealant at exterior thresholds
3. Division 08 – metal doors and frames, interior aluminum frames, wood doors, integrated security systems, specialty doors, storefront and glazed curtainwall systems.
4. Division 10 – operable partitions
5. Division 21 – fire and life safety systems
6. Division 28 – security access systems

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere.

1. Windows.
2. Cabinets, including open wall shelving and locks.
3. Signs, except where scheduled.
4. Toilet accessories, including grab bars.
5. Installation.
6. Rough hardware.
7. Conduit, junction boxes & wiring.
8. Folding partitions, except cylinders where detailed. Sliding aluminum doors, except cylinders where detailed.
9. Access doors and panels, except cylinders where detailed.
10. Corner Guards.
11. Welded steel gates and supports.

1.2 REFERENCES:

A. Use date of standard in effect as of Bid date.

1. American National Standards Institute – ANSI 156.18 – Materials and Finishes.
    a) ICC/ANSI A117.1 - 2009 – Specifications for making buildings and facilities usable by physically handicapped people.
    b) ANSI A156.18 Materials and Finishes
2. ADAAG – Americans with Disabilities Act Accessibility Guidelines of 2010
3. BHMA – Builders Hardware Manufacturers Association
4. DHI – Door and Hardware Institute
5. NFPA – National Fire Protection Association
    a) NFPA 80 – Fire Doors and Windows
    b) NFPA 105 – Smoke and Draft Control Door Assemblies
    c) NFPA 252 – Fire Tests of Door Assemblies
6. UL – Underwriters Laboratories
    a) UL10C – Positive Pressure Fire Tests of Door Assemblies.
    b) UL 305 – Panic Hardware
7. WHI – Warnock Hersey Incorporated
8. Local applicable codes
9. SDI – Steel Door Institute
10. WI – Woodwork Institute
11. AWI – Architectural Woodwork Institute
12. NAAMM – National Association of Architectural Metal Manufacturers

B. Abbreviations

1. Manufacturers: see table at 2.1.A of this section
2. Finishes: see 2.7 of this section.

1.3 SUBMITTALS & SUBSTITUTIONS

A. SUBMITTALS: Submit six copies of schedule per Section 01330. Only submittals printed one sided will be accepted and reviewed. Organize vertically formatted schedule into "Hardware Sets" with index of doors and headings, indicating complete designations of every item required for each door or opening. Minimum 10pt font size. Include following information:

1. Type, style, function, size, quantity and finish of hardware items.
2. Use BHMA Finish codes per ANSI A156.18.
3. Name, part number and manufacturer of each item.
4. Fastenings and other pertinent information.
5. Location of hardware set coordinated with floor plans and door schedule.
6. Explanation of abbreviations, symbols, and codes contained in schedule.
7. Mounting locations for hardware.
8. Door and frame sizes, materials and degrees of swing.
9. List of manufacturers used and their nearest representative with address and phone number.
10. Catalog cuts.
11. Point-to-point wiring diagrams.
12. Manufacturer's technical data and installation instructions for electronic hardware.

B. Bid and submit manufacturer's updated/improved item if scheduled item is discontinued.

C. Deviations: Highlight, encircle or otherwise identify deviations from "Schedule of Finish Hardware" on submittal with notations clearly designating those portions as deviating from this section.

D. If discrepancy between drawings and scheduled material in this section, bid the more expensive of the two choices, note the discrepancy in the submittal and request direction from Architect for resolution.

E. Substitutions per Division 1. Include product data and indicate benefit to the Project. Furnish operating samples on request.

F. Items listed with no substitute manufacturers have been requested by Owner to meet existing standard.

G. Furnish as-built/as-installed schedule with closeout documents, including keying schedule, riser and point-to-point wiring diagrams, manufacturers' installation, adjustment and maintenance information, and supplier's final inspection report.

1.4 QUALITY ASSURANCE:

A. Qualifications:

1. Hardware supplier: direct factory contract supplier who employs a certified architectural hardware consultant (AHC), available at reasonable times during course of work for project hardware consultation to Owner, Architect and Contractor.

a) Responsible for detailing, scheduling and ordering of finish hardware. Detailing implies that the submitted schedule of hardware is correct and complete for the intended function and performance of the openings.

B. Hardware: Free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.

C. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.

D. Fire-Rated Openings: NFPA 80 compliant. Hardware UL10C Standard 7-2 (positive pressure) compliant for given type/size opening and degree of label. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, and resilient seals. Coordinate with wood door section for required intumescent seals. Furnish openings complete.

E. Furnish hardware items required to complete the work in accordance with specified performance level and design intent, complying with manufacturers' instructions and code requirements.

F. Pre-Installation Meetings: Initiate and conduct with supplier, installer and related trades, coordinate materials and techniques, and sequence complex hardware items and systems installation. Include manufacturers' representatives of locks, panic hardware and door closers in the meetings. Convene prior to commencement of related work.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Delivery: coordinate delivery to appropriate locations (shop or field).

1. Permanent keys and cores: secured delivery direct to Owner's representative.

B. Acceptance at Site: Items individually packaged in manufacturers' original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.

C. Storage: Provide securely locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, dust, excessive heat and cold, etc.

1.6 PROJECT CONDITIONS AND COORDINATION:

A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical the same operation and quality as type specified, subject to Architect's approval.

B. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents. Furnish related trades with the following information:

1. Location of embedded and attached items to concrete.
2. Location of wall-mounted hardware, including wall stops.
3. Location of finish floor materials and floor-mounted hardware.
4. At masonry construction, coordinate with the anchoring and hollow metal supplier prior to frame installation by placing a strip of insulation, wood, or foam, on the back of the hollow metal frame behind the rabbet section for continuous hinges, as well as at rim panic hardware strike locations, silencers, coordinators, and door closer arm locations. When the frame is grouted in place, the backing will allow drilling and tapping without dulling or breaking the installer's bits.
5. Locations for conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety system interfacing. Point-to-point wiring diagrams plus riser diagrams to related trades.
6. Coordinate: flush top rails of doors at outswinging exteriors, and throughout where adhesive-mounted seals occur.
7. Manufacturers' templates to door and frame fabricators.

C. Check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.

D. Environmental considerations: segregate unused recyclable paper and paper product packaging, uninstalled metals, and plastics, and have these sent to a recycling center.

1.7 WARRANTY:

A. Part of respective manufacturers' regular terms of sale. Provide manufacturers' written warranties:

1.	Locksets:	Three years
2.	Extra Heavy Duty Cylindrical Lock:	Ten Years
3.	Exit Devices:	Three years mechanical One year electrical
4.	Closers:	Ten years mechanical - 4040XP Thirty years mechanical - 1460
5.	Hinges:	Ten years

1.8 COMMISSIONING:

A. Conduct these tests prior to request for certificate of substantial completion:

1. With installer present, test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.
2. With installer, access control contractor and electrical contractor present, test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.
3. With installer and electrical contractor present, test hardware interfaced with fire/life-safety system for proper operation and release.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers and their abbreviations used in this schedule:

GLY	Glynn-Johnson Hardware
IVE	H. B. Ives
LCN	LCN Closers
PEM	Pemko
SCE	Schlage Electronics
SCH	Schlage Lock Company
VON	Von Duprin
ZER	Zero International

2.2 HINGING METHODS:

A. Drawings typically depict doors at 90 degrees, doors will actually swing to maximum allowable. Use wide-throw conventional or continuous hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180-degree opening. Advise architect if 8-inch width is insufficient.

B. Conform to manufacturer's published hinge selection standard for door dimensions, weight and frequency, and to hinge selection as scheduled. Where manufacturer's standard exceeds the scheduled product, furnish the heavier of the two choices, notify Architect of deviation from scheduled hardware.

C. Conventional Hinges: Steel or stainless steel pins and concealed bearings. Hinge open widths minimum, but of sufficient throw to permit maximum door swing.

1. Outswinging exterior doors: non-ferrous with non-removable (NRP) pins and security studs.
2. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.

D. Continuous Hinges:

1. Geared-type aluminum.

a) Use wide-throw units where needed for maximum degree of swing, advise architect if commonly available hinges are insufficient.
b) If units are used at storefront openings, color-coordinate hinge finish with storefront color. Custom anodizing and custom powdercoat finishes subject to Architect approval.

2.3 LOCKSETS, LATCHSETS, DEADBOLTS:

A. Mortise Locksets and Latchsets: as scheduled.

1. Chassis: cold-rolled steel, handing field-changeable without disassembly.
2. Universal lock case – 10 functions in one case.
3. Floating mounting tabs automatically adjusts to fit a beveled door edge.
4. Latchbolts: 0.75 inch throw stainless steel anti-friction type.
5. Lever Trim: through-bolted, accessible design, cast lever or solid extruded bar type levers as scheduled. Filled hollow tube design unacceptable.
    a) Spindles: security design independent breakaway. Breakage of outside lever does not allow access to inside lever's hubworks to gain wrongful entry.
    b) Inside lever applied by screwless shank mounting – no exposed trim mount screws.
    c) Levers rotate up or down for ease of use.
6. Furnish solid cylinder collars with wave springs. Wall of collar to cover rim of mortise cylinder.
7. Thumbturns: accessible design not requiring pinching or twisting motions to operate.
8. Deadbolts: stainless steel 1-inch throw.
9. Electric operation:
    a) Manufacturer-installed continuous duty solenoid.
    b) 12/24 volt compatibility – auto detect
    c) Fail Safe/Secure – customer selectable
    d) .04 amp - maximum current draw, any voltage
    e) .010 amp - holding current
    f) RX switch modular – field reversible
10. Strikes: 16 gage curved steel, bronze or brass with 1 inch deep box construction, lips of sufficient length to clear trim and protect clothing.
11. Scheduled Lock Series and Design: Schlage L series, M52A design.
12. Certifications:
    a) ANSI A156.13, 1994, Grade 1 Operational, Grade 1 Security.
    b) ANSI/ASTM F476-84 Grade 31 UL Listed.

2.4 EXIT DEVICES / PANIC HARDWARE

A. General features:

1. Independent lab-tested 1,000,000 cycles.
2. Push-through push-pad design. No exposed push-pad fasteners, no exposed cavities when operated. Return stroke fluid dampeners and rubber bottoming dampeners, plus anti-rattle devices.
3. Deadlocking latchbolts, 0.75 inch projection.
4. End caps: impact-resistant, flush-mounted. No raised edges or lips to catch carts or other equipment.
5. No exposed screws to show through glass doors.
6. Non-handed basic device design with center case interchangeable with all functions, no extra parts required to effect change of function.
7. Releasable in normal operation with 15-pound maximum operating force, and with 32-pound maximum pressure under 250-pound load to the door.

B. Specific features:

1. Lever Trim: breakaway type, forged brass or bronze escutcheon min. 0.130 inch thickness, compression spring drive, match lockset lever design.
2. Rod and latch guards with sloped full-width kickplates for doors fitted with surface vertical rod devices with bottom latches.
3. Fire-Labeled Devices: UL label indicating “Fire Exit Hardware”. Vertical rod devices less bottom rod (LBR) unless otherwise scheduled.
4. Inpact recessed devices: 1.25 inch projection when push-pad is depressed. Sloped metal end caps to deflect carts, etc. No pinch points to catch skin between touchbar and door.
5. Delayed Egress Devices: Function achieved within single exit device component, including latch, delayed locking device, request-to-exit switch, nuisance alarm, remote alarm, key switch, indicator lamp, relay, internal horn, door position input, external inhibit input plus fire alarm input. NFPA 101 “Special Locking Arrangement” compliant.
6. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
7. Exit Device meeting this specification: Von Duprin 33A/99

2.5 POWER SUPPLIES/ TRANSFERS

A. Power supplies to be tested and certified to meet UL294.
B. Universal 120-240 VAC input, low voltage DC output, regulated and filtered.
C. Power supplies to have 2A, 4A, 6A output, 12/24 VDC field selectable with jumper.
D. Provide emergency release terminals, where required, that allow the release of all devices upon activation of the fire alarm system complete with fire alarm input for initiating "no delay" exiting mode.
E. Power supplies for Von Duprin and Falcon/ Monarch electric latch retraction shall be 4A, and include a high inrush module as required for electric latch retraction.
F. Power supplies shall be flat mounting design with polarized locking connections for additional option boards as specified.
G. Power supplies shall be of the same manufacture as electrified exit devices and or locking devices. Substitutions will not be considered or approved.
H. Provide a means to transfer power from the door frame to door style. Devices shall be reversible and allow a full 180 degree door swing. When door is closed transfer unit shall be concealed.
I. Provide Von Duprin EPT power transfers with swiveling stainless steel tube at all electrified locks and exit devices. Von Duprin EPT shall be used at all exits that require a high amp inrush to retract latch. Power transfer hinges or coiled spring power transfers will not be acceptable.

2.6 CLOSERS

A. Surface Closers (Exterior):

1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body. Double heat-treated pinion shaft, single piece forged piston, chrome-silicon steel spring.
2. ISO 2000 certified. Units stamped with date-of-manufacture code.
3. Non-sized, non-handed, and adjustable. Place closer inside building, stairs, and rooms.
4. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
5. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
6. Extra-duty arms (EDA) solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers with parallel arm units at doors scheduled with parallel arm units.
7. Exterior door closers: tested to 100 hours of ASTM B117 salt spray test, furnish data on request.
8. Exterior doors: seasonal adjustments not required for temperatures from 120 degrees F to -30 degrees F, furnish checking fluid data on request.
9. Non-flaming fluid, will not fuel door or floor covering fires.
10. Pressure Relief Valves (PRV) not permitted.
11. Closer meeting this specification: LCN 4040XP

B. Surface Closers (Interior):

1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body. Double heat-treated pinion shaft, single piece forged piston, chrome-silicon steel spring.
2. ISO 2000 certified. Units stamped with date-of-manufacture code.
3. Non-sized, non-handed and adjustable. Place closers inside building, stairs and rooms.
4. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
5. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
6. Extra-duty arms (EDA) solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers with parallel arm units at doors scheduled with parallel arm units.
7. Exterior door closers: tested to 100 hours of ASTM B117 salt spray test, furnish data on request.
8. Exterior doors: seasonal adjustments not required for temperatures from 120 degrees F to 0 degrees F, furnish checking fluid data on request.
9. Non-flaming fluid, will not fuel door or floor covering fires.
10. Pressure Relief Valves (PRV) not permitted.
11. Closer meeting this specification: LCN 1460

2.7 OTHER HARDWARE

A. Automatic Flush Bolts: Low operating force design.

B. Overhead Stops: Non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.

C. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.

D. Door Stops: Provide stops to protect walls, casework or other hardware.

1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where floor type cannot be used, provide wall type. If neither can be used, provide overhead type.

E. Locate overhead stops for maximum possible opening. Consult with Owner for furniture locations. Minimum: 90deg stop / 95deg deadstop. Note degree of opening in submittal.

F. Seals: Adhesive type at head & jambs. Inelastic, rigid back, not subject to stretching. Self-compensating for warp, thermal bow, door settling, and out-of-plumb. Adhesive warranted for life of installation.

1. Proposed substitutions: submit for approval.

G. Thresholds: As scheduled and per details. Substitute products: certify that the products equal or exceed specified material's thickness. Proposed substitutions: submit for approval.

1. Saddle thresholds: 0.200 inches minimum thickness.

H. Exteriors: Seal perimeter to exclude water and vermin. Use sealant complying with requirements in Division 7 "Thermal and Moisture Protection". Minimum 0.25 inch diameter fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors (SS/FHSL).

I. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.

J. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHSL) may be slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.

K. Through-bolts: Verify with Architect. Coordinate with wood doors; ensure provision of proper blocking to support wood screws for mounting panic hardware and door closers. Coordinate with metal doors and frames; ensure provision of proper reinforcement to support machine screws for mounting panic hardware and door closers.

1. Exception: surface-mounted overhead stops, holders, and friction stays.

L. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Leave no unfilled/uncovered pre-punched silencer holes. Intent: door bears against silencers, seals make minimal contact with minimal compression – only enough to effect a seal.

2.8 FINISH:

A. Generally: BHMA 626 Satin Chromium Steel OR BHMA 630 Satin Stainless Steel.

1. Areas using BHMA 626: furnish push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise scheduled.

B. Door closers: factory powder coated to match other hardware, unless otherwise noted.

1. Provide satin-chrome plated arms, tracks and covers where scheduled bright metallic powder coat (MTLPC) not available.

C. Finish designators used in appended hardware schedule:

ANSI	US	Description	Base Metal
600	USP	Primed For Painting	Steel
626	US26D	Satin Chromium Plated Over Nickel	Brass, Bronze
626AM	US26D	Satin Chromium Plated Over Nickel With Antimicrobial Coating	Brass, Bronze
628	US28	Satin Aluminum, Clear Anodized	Aluminum
630	US32D	Satin Stainless Steel	Stain. Steel 300 Ser
652	US26D	Satin Chromium Plated Over Nickel	Steel
689	US28	Aluminum Painted	Any
AL	US28	Aluminum Mill Finish	Aluminum
BLK		Black	Any
BRN		Dark Brown	Any
CL		Clear Anodized	Aluminum
GRY		Grey	Any

D. Seal color to be as selected by Architect.

2.9 KEYING REQUIREMENTS:

A. Key System: Schlage Primus high-security utility-patented keyway, interchangeable core throughout. Key blanks available only from factory-direct sources, not available from after-market keyblank manufacturers. For estimate use factory GMK charge. Initiate and conduct meeting(s) with Owner and Allegion representatives to determine system keyway(s), keybow styles, structure, stamping, degree of physical security and degree of geographic exclusivity. Furnish Owner's written approval of the system; do not order keys or cylinders without written confirmation of actual requirements from the Owner. Owner/Contractor will install permanent cylinders/cores.

1. New master key system.

B. Primus Level 9
C. Construction keying: furnish temporary keyed-alike cores. Remove at substantial completion and install permanent cylinders/cores in Owner's presence. Demonstrate that construction key no longer operates.
D. Temporary cylinders/cores remain supplier's property.
E. Furnish 10 construction keys.
F. Furnish 2 construction control keys.
G. Key Cylinders: furnish 6-pin solid brass construction.
H. Cylinders/cores: keyed at factory of lock manufacturer where permanent records are maintained. Locksets and cylinders same manufacturer.
I. Permanent keys: use secured shipment direct from point of origination to Owner.

1. For estimate: 2 keys per lockset, 5 master keys per group, 5 grand-master keys, 3 control keys.

J. For estimate: VKC stamping plus "DO NOT DUPLICATE".
K. Bitting List: use secured shipment direct from point of origination to Owner at completion.

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS:

A. Can read and understand manufacturers' templates, suppliers' hardware schedule and printed installation instructions. Can readily distinguish drywall screws from manufacturers' furnished fasteners. Available to meet with manufacturers' representatives and related trades to discuss installation of hardware.

3.2 PREPARATION:

A. Ensure that walls and frames are square and plumb before hardware installation. Make corrections before commencing hardware installation. Installation denotes acceptance of wall/frame condition.

B. Locate hardware per SDI-100 and applicable building, fire, life-safety, accessibility, and security codes.

1. Notify Architect of code conflicts before ordering material.
2. Locate latching hardware between 34 inches to 44 inches above the finished floor, per California Building Code, Section 1008.1.9.2 and 1133B.2.5.2.
3. Locate panic hardware between 36 inches to 44 inches above the finished floor.
4. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.

C. Overhead stops: before installing, determine proposed locations of furniture items, fixtures, and other items to be protected by the overhead stop's action.

3.3 INSTALLATION

A. Install hardware per manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation. Remove and reinstall or replace work deemed defective by Architect.

1. Gaskets**:** install jamb-applied gaskets before closers, overhead stops, rim strikes, etc; fasten hardware over and through these seals. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
3. Use manufacturers' fasteners furnished with hardware items, or submit Request for Substitution with Architect.
4. Replace fasteners damaged by power-driven tools.

B. Locate floor stops no more than 4 inches from walls and not within paths of travel. See paragraph 2.2 regarding hinge widths, door should be well clear of point of wall reveal. Point of door contact no closer to the hinge edge than half the door width. Where situation is questionable or difficult, contact Architect for direction.

C. Core concrete for exterior door stop anchors. Set anchors in approved non-shrink grout.

D. Locate overhead stops for minimum 90 degrees at rest and for maximum allowable degree of swing.

E. Install closers inside building, stairs, and rooms as scheduled.

F. Drill pilot holes for fasteners in wood doors and/or frames.

G. Before hardware installation is begun, hardware supplier shall brief installers on proper hardware installation so that items are installed in accordance with manufacturer's installation instructions. Hardware supplier shall inspect all work for proper hardware operations and shall give written maintenance and operation instructions to the Owner. Construction cores installed by Contractor shall be used during construction.
H. Flush bolts shall be installed concealed in inactive leafs.
I. Install rubber door silencers at each door frame.

3.4 ADJUSTING

A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.

1. Hardware damaged by improper installation or adjustment methods: repair or replace to Owner's satisfaction.
2. Adjust doors to fully latch with no more than 1 pound of pressure.
3. Adjust delayed-action closers on fire-rated doors to fully close from fully-opened position in no more than 10 seconds.
4. Adjust door closers per 1.9 this section.

B. Fire-rated doors:

1. Wood doors: adjust to 0.125 inches clearance at heads, jambs, and meeting stiles.
2. Steel doors: adjust to 0.063 inches minimum to 0.188 inches maximum clearance at heads, jambs, and meeting stiles.
3. Adjust wood and steel doors to 0.75 inches maximum clearance (undercut) above threshold or finish floor material under door.

C. Adjust closers to meet ADA
D. Final inspection: Installer to provide letter to Owner that upon completion installer has visited the Project and has accomplished the following:

1. Has re-adjusted hardware.
2. Has evaluated maintenance procedures and recommend changes or additions, and instructed Owner's personnel.
3. Has identified items that have deteriorated or failed.
4. Has submitted written report identifying problems.

3.5 DEMONSTRATION:

A. Demonstrate mechanical hardware and electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.6 PROTECTION/CLEANING:

A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
B. Clean adjacent wall, frame and door surfaces soiled from installation / reinstallation process.

3.7 SCHEDULE OF FINISH HARDWARE

SPEXTRA: 449464

HARDWARE GROUP NO. 103

FOR USE ON MARK/DOOR #(S):
105 109

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050T M52A L583-363	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 201

FOR USE ON MARK/DOOR #(S):
205

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 201W

FOR USE ON MARK/DOOR #(S):
139A ~~203~~

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	FLOOR STOP	FS436/FS438	626	IVE
1	EA	GASKETING	188S PSA H & J	BK	ZER
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER

HARDWARE GROUP NO. 203

FOR USE ON MARK/DOOR #(S):
139B

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 210

FOR USE ON MARK/DOOR #(S):
202A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	SET	CONST LATCHING BOLT	FB51P/FB61P AS REQ	630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2 AS REQ	626	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
2	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	PROTECTION PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	FLOOR STOP	FS436/FS438	626	IVE
2	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 210G

FOR USE ON MARK/DOOR #(S):
138

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	SET	CONST LATCHING BOLT	FB51P/FB61P AS REQ	630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2 AS REQ	626	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	OH STOP & HOLDER	90H SERIES X SIZE & MOUNTING AS REQ (INACTIVE LEAF)	630	GLY
1	EA	SURFACE CLOSER	1461 SCUSH X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	GASKETING	188S PSA H & J	BK	ZER
2	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER

HARDWARE GROUP NO. 341

FOR USE ON MARK/DOOR #(S):

102	107	125	126	127	128
136A	136B				

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	L9040 M52A L583-363 L283-722	626	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

-"OCCUPIED/VACANT" INDICATOR ON OUTSIDE OF DOOR.

HARDWARE GROUP NO. 403G

FOR USE ON MARK/DOOR #(S):

106	120	121	122	123	124
129	130	131	132	133	

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	L9010 M52A	626	SCH
1	EA	FLOOR STOP	FS436/FS438	626	IVE
1	EA	GASKETING	188S PSA H & J	BK	ZER
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER

HARDWARE GROUP NO. 501

FOR USE ON MARK/DOOR #(S):
119A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	L9070T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 501CG

FOR USE ON MARK/DOOR #(S):
134A 134B

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	L9070T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	1461 SCUSH X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188S PSA H & J	BK	ZER
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER

HARDWARE GROUP NO. 501W

FOR USE ON MARK/DOOR #(S):
204

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
1	EA	CLASSROOM LOCK	L9070T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

~~HARDWARE GROUP NO. 701G~~

~~FOR USE ON MARK/DOOR #(S):~~
~~110B~~ ~~135B~~

~~PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:~~

~~QTY~~		~~DESCRIPTION~~	~~CATALOG NUMBER~~	~~FINISH~~	~~MFR~~
~~3~~	~~EA~~	~~HINGE~~	~~5BB1 4.5 X 4.5 NRP~~	~~652~~	~~IVE~~
~~1~~	~~EA~~	~~PANIC HARDWARE~~	~~99-L-M52 LENGTH AS REQ~~	~~626~~	~~VON~~
~~1~~	~~EA~~	~~RIM HOUSING~~	~~20-079~~	~~626~~	~~SCH~~
~~1~~	~~EA~~	~~PRIMUS CORE~~	~~20-740~~	~~626~~	~~SCH~~
~~1~~	~~EA~~	~~FSIC CONST. CORE~~	~~23-030 ICX~~	~~622~~	~~SCH~~
~~1~~	~~EA~~	~~SURFACE CLOSER~~	~~1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ~~	~~689~~	~~LCN~~
~~1~~	~~EA~~	~~PROTECTION PLATE~~	~~8400 10" X 2" LDW B-CS~~	~~630~~	~~IVE~~
~~1~~	~~EA~~	~~FLOOR STOP~~	~~FS436/FS438~~	~~626~~	~~IVE~~
~~1~~	~~EA~~	~~GASKETING~~	~~188S PSA H & J~~	~~BK~~	~~ZER~~
~~1~~	~~EA~~	~~DOOR SWEEP~~	~~39A LENGTH AS REQ~~	~~A~~	~~ZER~~
~~1~~	~~EA~~	~~THRESHOLD~~	~~655A LENGTH AS REQ~~	~~A~~	~~ZER~~

HARDWARE GROUP NO. 715A

FOR USE ON MARK/DOOR #(S):
101

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112HD HEIGHT AS REQ	628	IVE
1	EA	PANIC HARDWARE	33A-NL-OP LENGTH AS REQ	626	VON
1	EA	RIM HOUSING	20-079	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	622	SCH
1	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MANUFACTURER		
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER

HARDWARE GROUP NO. 903

FOR USE ON MARK/DOOR #(S):
115 116 117

PROVIDE EACH SL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	OPEN RAIL TRACK/HARDWARE	OBF80 SINGLE DOOR OBF80-20		BRI
1	EA	DOOR PULL, 1" ROUND	PR 8103EZHD 10" N	630	IVE

COORDINATE AND VERIFY ALL DOOR/HARDWARE REQUIREMENTS WITH BRIO BEFORE ORDERING DOOR & ADDITIONAL HARDWARE.

HARDWARE GROUP NO. C201

FOR USE ON MARK/DOOR #(S):

103 112

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	ELECTRIC STRIKE	6211-FSE-CON (FAIL SECURE) VOLTAGE AS REQ	630	VON
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	WHT	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

COORDINATE ELECTRIC STRIKE WITH LOW VOLTAGE CONTRACTOR BEFORE ORDERING.

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY LEVER. UPON POWER FAILURE, DOOR TO REMAIN LOCKED (FAIL SECURE).

HARDWARE GROUP NO. C201W

FOR USE ON MARK/DOOR #(S):
203

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	ELECTRIC STRIKE	6211-FSE-CON (FAIL SECURE) VOLTAGE AS REQ	630	VON
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	WHT	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

COORDINATE ELECTRIC STRIKE WITH LOW VOLTAGE CONTRACTOR BEFORE ORDERING.

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY LEVER. UPON POWER FAILURE, DOOR TO REMAIN LOCKED (FAIL SECURE).

HARDWARE GROUP NO. C205

FOR USE ON MARK/DOOR #(S):
140

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	ELECTRIC STRIKE	6211-FSE-CON (FAIL SECURE) VOLTAGE AS REQ	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	WHT	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

COORDINATE ELECTRIC STRIKE WITH LOW VOLTAGE CONTRACTOR BEFORE ORDERING.

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY LEVER. UPON POWER FAILURE, DOOR TO REMAIN LOCKED (FAIL SECURE).

HARDWARE GROUP NO. C701A

FOR USE ON MARK/DOOR #(S):
104

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112HD EPT HEIGHT AS REQ	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-33A-NL-OP-CON LENGTH AS REQ	626	VON
1	EA	RIM HOUSING	20-079	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	622	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	FLOOR STOP	FS436/FS438	626	IVE
1	SET	SEAL	PERIMETER SEAL BY FRAME MANUFACTURER		
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	WHT	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY PUSH PAD. UPON POWER FAILURE, DOOR TO REMAIN LOCKED (FAIL SECURE).

HARDWARE GROUP NO. C701G

FOR USE ON MARK/DOOR #(S):
110A 110B 135A 135B

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-99-L-E996-M52-FSE-CON LENGTH AS REQ	626	VON
1	EA	RIM HOUSING	20-079	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	622	SCH
1	EA	SURFACE CLOSER	1461 REG/PA X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436/FS438	626	IVE
1	EA	GASKETING	188S PSA H & J	BK	ZER
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	WHT	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY PUSH PAD. UPON POWER FAILURE, DOOR TO REMAIN LOCKED (FAIL SECURE).

HARDWARE GROUP NO. C715

FOR USE ON MARK/DOOR #(S):

118A 118B 119B 137G 137H

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-99-L-NL-M52-CON LENGTH AS REQ	626	VON
1	EA	RIM HOUSING	20-079	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	622	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	PROTECTION PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	WHT	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY PUSH PADS. UPON POWER FAILURE, DOOR TO REMAIN LOCKED.

HARDWARE GROUP NO. C715A

FOR USE ON MARK/DOOR #(S):
114

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112HD EPT HEIGHT AS REQ	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-33A-NL-OP-CON LENGTH AS REQ	626	VON
1	EA	RIM HOUSING	20-079	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	FSIC CONST. CORE	23-030 ICX	622	SCH
1	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MANUFACTURER		
1	EA	DOOR SWEEP	39A LENGTH AS REQ	A	ZER
1	EA	THRESHOLD	655A LENGTH AS REQ	A	ZER
1	EA	CREDENTIAL READER	BY CONVERGINT TECHNOLOGIES		
1	EA	DOOR CONTACT	BY CONVERGINT TECHNOLOGIES	628	SCE
1	EA	POWER SUPPLY	BY CONVERGINT TECHNOLOGIES	LGR	SCE

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. INGRESS BY VALID CARD READ OR MANUAL KEY OVERRIDE. FREE EGRESS AT ALL TIME BY PUSH PADS. UPON POWER FAILURE, DOOR TO REMAIN LOCKED.

HARDWARE GROUP NO. G203S

FOR USE ON MARK/DOOR #(S):
202B

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	GATE HINGE	BY GATE MANUFACTURER	BLK	B/O
1	EA	STOREROOM LOCK	L9080T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	OH STOP	90S SERIES X SIZE & MOUNTING AS REQ	630	GLY

COORDINATE ALL HARDWARE WITH WIRE GATE MANUFACTURER. PROVIDE MOUNTING FOR LOCKSET AND OVERHEAD STOP.

HARDWARE GROUP NO. W101

FOR USE ON MARK/DOOR #(S):
108A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	MULT PT OFFICE/ENTRY	LM9350T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	4040XP OR P4040XP X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	FLOOR STOP	FS436/FS438	626	IVE
1	EA	GASKETING	188S PSA H & J	BK	ZER

HARDWARE SET IS A GUIDELINE FOR STORM/TORNADO RESISTANT SHELTER. COORDINATE AND VERIFY WITH DOOR/FRAME MANUFACTURER HARDWARE IS IN COMPLIANCE WITH ICC 500.

HARDWARE GROUP NO. W201

FOR USE ON MARK/DOOR #(S):
108B

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	MULT PT STOREROOM	LM9380T M52A	626	SCH
1	EA	PRIMUS CORE	20-740	626	SCH
1	EA	SURFACE CLOSER	4040XP OR P4040XP X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	FLOOR STOP	FS436/FS438	626	IVE
1	EA	GASKETING	188S PSA H & J	BK	ZER

HARDWARE SET IS A GUIDELINE FOR STORM/TORNADO RESISTANT SHELTER. COORDINATE AND VERIFY WITH DOOR/FRAME MANUFACTURER HARDWARE IS IN COMPLIANCE WITH ICC 500.

3.8 DOOR/HARDWARE INDEX

Mark #	HWSet #
101	715A
102	341
103	C201
104	C701A
105	103
106	403G
107	341
108A	W101
108B	W201
109	103
110A	C701G
110B	C701G
112	C201
114	C715A
115	903
116	903
117	903
118A	C715
118B	C715
119A	501
119B	C715
120	403G
121	403G
122	403G
123	403G
124	403G
125	341
126	341
127	341
128	341
129	403G
130	403G
131	403G
132	403G
133	403G
134A	501CG
134B	501CG
135A	C701G
135B	C701G
136A	341
136B	341

Mark #	HWSet #
137G	C715
137H	C715
138	210G
139A	201W
139B	203
140	C205
202A	210
202B	G203S
203	C201W
204	501W
205	201

END OF SECTION 08 71 00

SECTION 08 72 00 – WEATHERSTRIPPING AND SEALS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Section Includes: Brush Weatherstrip.

B. Related Sections include the following:
   1. Division 08 Section "Steel Coiling Doors."

1.03 REFERENCES

A. ASTM International:
   1. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   2. ASTM E1408 Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.
   3. ASTM E2074 Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies.

B. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
   1. ANSI/BHMA A156.18: Materials and Finishes.
   2. ANSI/BHMA A156.22: Door Gasketing Systems.

C. American National Standards Institute/Steel Door Institute (ANSI/SDI):
   1. ANSI A250.8/SDI-100 Recommended Specifications for Standard Steel Doors and Frames.

D. American National Standards Institute/Window and Door Manufacturers Association (ANSI/WDMA):
   1. ANSI/WDMA I.S.1-A Architectural Wood Flush Doors.

E. Underwriters Laboratories, Inc. (UL):

1. UL 10B Fire Tests of Door Assemblies.
2. UL 10C Fire Tests of Door Assemblies.
3. UL 1784 Air Leakage Tests of Door Assemblies.

F. International Code Council (ICC):
1. UBC 7-2 Fire Test of Door Assemblies (Positive Pressure).
2. International Building Code (IBC) Code 2000 (Positive Pressure).

G. British Standards (BS):
1. BS 476 Fire Tests on Building Materials and Structures.

H. National Fire Protection Association (NFPA):
1. NFPA 105 Recommended Practice for the Installation of Smoke-Control Door Assemblies.

1.04 SYSTEM DESCRIPTION

A. Design Requirements: Provide brush weatherstrip which have been manufactured, fabricated and installed to meet the following design criteria:
1. Acoustical Performance ASTM E90, ASTM E1408.
2. Provide performance obtained from test procedures UBC 7-2.
3. Smoke, Air Leakage: Comply with NFPA 105.

1.05 SUBMITTALS

A. Comply with pertinent provisions of Division 01 Section "Submittal Procedures, unless otherwise indicated."

B. Product Data: Submit manufacturer's product data and installation instructions.

C. Shop Drawings: Provide drawings indicating required component locations, interface with adjacent materials, installation, anchorage, fastening and similar information.

D. Samples: Submit one each of manufacturer's standard selection samples.

E. Quality Assurance/Control Submittals: Submit the following:
1. Test Reports: Upon request, submit Durability test reports from recognized testing laboratory.
2. Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.

F. Closeout Submittals: Submit the following:
1. Warranty documents specified herein.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity.

B. Mock-Ups:
   1. Subject to acceptance by owner, mock-up may be retained as part of finish work.
   2. If mock-up is not retained, remove and properly dispose of mock-up.

1.07 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 01 Product Requirement Section.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1.08 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
   1. Warranty Period: 3 years against defects in materials or workmanship, beginning with Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERIMETER GASKETING AND BRUSH WEATHERSTRIP

A. Manufacturer: Pemko Manufacturing Company.

1. Contact: PO Box 3780, 4226 Transport Street, Ventura, CA 93003; Telephone: (800) 283-9988, (805) 642-2600; Fax: (805) 642-4109; E-mail: pemkosales@pemko.com; website: www.pemko.com.

B. Proprietary Products/Systems: Brush weatherstrip, including the following:
   1. 180 Degree Aluminum Retainer Brush Weatherstrip:
      a. Material: Extruded tempered aluminum 6063-T6.
      b. Finish (ANSI/BHMA A156.18): Clear anodized aluminum.
      c. Brush Construction: Densely compressed nylon filaments encased in galvanized retainer.
      d. Color: Aluminum color, gray nylon.
      e. Manufacturer Model Number: 18400CNB.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

A. Comply with the instructions and recommendations of the brush weatherstrip manufacturer.

3.02 EXAMINATION

A. Site Verification of Conditions:
   1. Verify that site conditions are acceptable for installation of brush weatherstrip.
      a. Examine doors and frames for compliance with requirements for door and frame manufacturer's installation tolerances, labeled fire door assembly construction, wall and floor construction and other conditions affecting performance.
   2. Do not proceed with installation of brush weatherstrip until unacceptable conditions are corrected.

3.03 PREPARATION

A. Wood Door Preparation:
   1. Comply with ANSI/WDMA I.S.1-A.
   2. Comply with door manufacturer's positive pressure installation instructions.

B. Steel Door and Frame Preparation:
   1. Drill and tap doors and frames for hardware per manufacturer's positive pressure installation instructions.
   2. Ensure doors and frames are properly sized, plumb and square.
   3. Comply with ANSI A250.8/SDI-100.

3.04 INSTALLATION

A. Mounting Location: Comply with the following requirements, unless otherwise indicated:
   1. Steel Doors and Frames:
      a. Comply with manufacturer's positive pressure installation instructions.
      b. Comply with ANSI A250.8/SDI-100.
   2. Wood Doors:
      a. Comply with manufacturer's positive pressure installation instructions.
      b. Comply with ANSI/WDMA I.S.1-A.

B. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

C. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3.05 ADJUSTING

A. Perform adjustments required to ensure that brush weatherstrip function in compliance with manufacturer's performance criteria prior to acceptance by Owner.

3.06 CLEANING

A. Remove any protective films and clean components as necessary following manufacturer's recommended procedures.

3.07 PROTECTION

A. Protect installed work from damage due to subsequent construction activity on the site.

END OF SECTION 08 72 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide all glass and glazing as shown on the drawings and as herein specified.

B. Related Sections include the following:
   1. Division 5 Section "Metal Fabrications."
   2. Division 8, All "Door" and "Window" Sections.
   3. Division 8 Section "Aluminum Entrances and Storefront."

1.03 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of any insulating glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination material obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standards.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Review curtain wall and window shop drawings and submit acceptance of details as suitable for proposed glass products.

C. Submit 12-inch square samples of each type of glass indicated except for clear monolithic glass products, and 12-inch long samples of each color required (except black) for each type of sealant or gasket exposed to view.

1.05 INFORMATIONAL SUBMITTALS:

A. Qualification Data.

B. Product Certificates: Certificate of Compliance for all glass products.
   1. Insulating Glass Certification: Submit data verifying compliance with IGCC, Class A level.

C. Compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants and other glazing materials.
   1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Wind Pressure and Thermal Stress Analysis: Submit thermal stress analysis of glass where thermal stress may occur.

E. Sample Warranties: For special warranties.

F. Product Test Reports:
   1. Pre-construction adhesion and compatibility test report.
   2. Refer to Division 01 for field-testing requirements.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
      a. Glass fabricator to have 10 years of experience and meet ANSI / ASQC Q9002 1994.
   2. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certified Glass Installer Program.
   3. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

B. Coordination: Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the inspecting and testing agency, Insulating Glass Certification Council.

D. Installation Criteria: FGJA "Glazing Manual", in addition to any other referenced standards.

E. Single Source fabrication responsibility: Fabrication processes, including Low E and reflective coatings, insulating, laminating, silkscreen, and tempering, shall be fabricated by a single Fabricator.

F. Mockups: Before glazing, build mockups for each glass product indicated below to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities

of materials and execution. Build mockups using materials fully assembled and as indicated in drawings and specifications for the completed work.

1. Build mockups in combination with storefront mockup requirements.
2. Build mockups with the glass to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting fabrication.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.

1.07 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect glazing materials according to manufacturer’s written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun or other causes.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by the glazing material manufacturers and when glazing channel substrates are wet from rain, frost condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C)

1.10 WARRANTY

A. Warranty for Insulating Units: Warranty sealed insulating glass units for minimum period of ten (10) years, with manufacturer's replacement guarantee, covering as minimum: Defective or failure of seal; material vision obstruction as result of dust collection or film formation between panels or other similar failure and the following specific conditions:

1. Reflective glass whose reflective coating cracks, peels or discolors shall be replaced at no charge (material only) for minimum ten (10) year period beginning on date of Substantial Completion.

B. Warranty covers deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to the glass manufacturer's published instructions.

C. Glazing installer shall coordinate glass and glazing installation with framing systems, and install glass and glazing in accordance with manufacturer's instructions, so that guarantee is maintained.

PART 2 - PRODUCTS

2.01 DESIGN REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Provide glass lites in the thickness and strengths (annealed or heat-treated) to meet or exceed the following criteria based on analysis of Project loads and in-service conditions. Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses complying with ASTM E 1300 and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Specified Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.4.2, "Analytic Procedure," based on mean roof heights above grade indicated on Drawings.
2. Minimum glass thickness of lites composed of annealed or heat-treated glass are selected so the worst-case probability of failure does not exceed the following:
    a. Eight (8) lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action.
    b. One (1) lite per 1000 for lites set over 15 degrees off vertical and under action of wind or snow.
    c. Specified Design Wind Loads: As indicated on the Structural Drawings
    d. Minimum Glass Thickness for Exterior Lites: Not less than 6mm
    e. Thickness of Tinted and Heat-Absorbing glass: Provide the same thickness of each tint color indicated throughout Project.
3. Maximum Lateral Deflection: For the following types of glass supported on all four edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
    a. For monolithic-glass lites heat treated to resist wind loads.
    b. For insulating glass.
    c. For laminated-glass lites.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F , ambient; 180 deg F, material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 1/4" thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg .
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBNL WINDOW 6 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.
7. Solar Optical Properties: NFRC 300.

E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II, or Category IV Risk Factor as indicated in glass schedule.
1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

F. Insulating glass products are to be permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:
1. Insulating Glass Certification Council (IGCC).

G. Security Glazing: Applicable standards:
1. Consumer Product Safety Standard 16 CFR 1201, Category II
2. ANSI Z97.1, Safety Glazing Materials Used in Buildings
3. ASTM C1036, Flat Glass
4. ASTM C1172, Laminated Architectural Flat Glass
5. ASTM C1048, Heat-Treated Flat Glass
6. Fed. Spec. MIL-P-46144, Polycarbonate Plastic Sheet.

2.02 GLASS PRODUCTS, GENERAL

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this section or in referenced standards.
1. GANA Publications
   a. GANA Glazing Manual
   b. Laminated Glazing Reference Manual
   c. Tempering Division - Engineering Standards Manual
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
5. LSGA Publications.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
   1. Minimum Glass Thickness for Exterior Lites: 6 mm.
   2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.03 MANUFACTURERS

A. Basis of Design Products: Basis of Design products are indicated in the Glass Schedule later in this section. Provide Basis of Design products, or equal products as approved by Architect.

B. Manufacturers: Subject to compliance with Requirements, Manufacturers offering products acceptable for use on this project include the following:
   1. Oldcastle Building Envelope.
   2. Guardian Glass SunGuard.
   3. Pilkington North America.
   4. Viracon, Inc.
   5. Vitro Architectural Glass (Formerly PPG Ideascapes).

C. Fabricators for Insulating Glass Units:
   1. Basis of Design Fabricator: Viracon, Inc.

D. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

E. Fabricators for Specialty Glass and Specialty Glass Units: As specified with individual glass type descriptions.

2.04 GLASS PRODUCTS

A. Flat Glass
   1. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
   2. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.
   3. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

B. Heat-strengthened float glass: ASTM C 1048, Kind HS (heat-strengthened glass), Type I, Quality-Q3.
   1. Class 1 (clear) or Class 2 (tinted) as indicated.
   2. Condition A (uncoated), unless otherwise indicated.

C. Fully tempered float glass: ASTM C 1048. Kind fully tempered (FT), Quality-Q3.
   1. Class 1 (clear) or Class 2 (tinted) as indicated.
   2. Condition A (uncoated), unless otherwise indicated.

D. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.

1. ASTM E773 Seal Durability of Sealed Insulating Glass Units
2. ASTM E774 Sealed Insulating Glass Units
3. Sealed insulating glass units to be double sealed with a primary seal of black (or gray) polyisobutylene and a secondary seal of black (or gray) silicone.
4. Lites shall be separated by an aluminum spacer with 3 bent corners and 1 keyed-soldered corner, or 4 bent corners and a straight butyl injected zinc plated steel straight key joint, to provide a hermetically sealed and dehydrated air space.
   a. Aluminum Spacer Finish: Manufacturer's standard.
5. Units shall be certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) and tested in accordance with the above ASTM Test Methods.

E. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
   2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   3. Interlayer Color: Clear unless otherwise indicated.

F. Glass Mirrors: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
   1. Clear Glass: Mirror Select Quality.

2.05 MISCELLANEOUS GLAZING MATERIALS

A. General: Select glazing sealants, tapes, gaskets and other glazing materials of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.

B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

E. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.06 GLAZING SEALANTS

A. Cleaners, Primers, and Sealers, General: Types shall be as recommended by sealant or gasket manufacturer, and as specified in other Sections.
   1. Structural Glazing Sealants: ASTM C1184, and as recommended by glazing system Manufacturer.
   2. In event of conflicts, the most restrictive requirements acceptable to glazing system Manufacturers shall prevail.

B. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

C. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

D. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT **,** G, A, and O; SWRI validation.
   1. Basis of Design Product: Dow Corning Corporation, 795 Silicone Building Sealant.
   2. Application: Typical glazing application, unless otherwise indicated.

2.07 MISCELLANEOUS MIRROR MOUNTING MATERIALS

A. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
   1. Adhesive shall have a VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Mounting Accessories: Brushed stainless steel (Type 302) mirror clips similar to KV277 at bottom and KV278 at top in number as required to accommodate size of mirror.

2.08 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
   2. Temperature Change: 180 deg F, material surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Carefully inspect and verify all job site conditions and measurements.
   2. Verify prepared openings for glazing are correctly sized and within tolerance.
   3. Verify that a functioning weep system is present.
   4. Verify that the minimum required face and edge clearances are being followed.
   5. Verify effective sealing between joints of glass-framing members.
   6. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.
   7. Verify glazing channels are free of burrs, irregularities, and debris.
   8. Verify glass is free of edge damage or face imperfections.
   9. Inspect door and frames to determine that frames, sash, and stops are set true and straight. Sash rabbets and stops shall be clean and dry at time of glazing.

B. Do not proceed until unsatisfactory conditions have been corrected. Beginning installation constitutes acceptance of substrate / conditions.

3.02 PREPARATION

A. Provide glass manufacturer's recommended edge clearances when sizing glass.

B. Remove protective coatings from surfaces to be glazed.

C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrates indicated under the project conditions.
   1. Clean glazing channels and other framing members receiving glass immediately before glazing.
   2. Remove coatings not firmly bonded to substrates.
   3. Clean glass and glazing surfaces to remove dust, oil, and contaminants, and wipe dry.

D. Verify measurements of sash and openings at Project.
   1. Dimensions shown or indicated are given only as a guide for estimating purposes, and actual size shall be determined by measurement of the actual openings. Accurately cut glass to fit openings with proper clearances and setting block height.

E. Coordinate with and check Shop Drawings furnished by other suppliers of Work affecting this Section to avoid field installation problems.

F. Before glazing metal sash, remove oil, lacquer, or other material to which the compound will not readily adhere or which will tend to delaminate from metal and cause a leak through the glazing seal.

3.03 GLAZING

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in "GANA Glazing Manual" and in other referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance,

C. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

D. Glazing to fit line in rabbet with all edges straight and true. Size substantially as shown on the drawings, however Contractor shall fill sash and openings as actually constructed whether more or less than sizes given.

E. Material installed in a full bed of sealant, tooling finished surfaces smooth.

F. Mirrors installed using mirror glazing angles, concealed clips and mirror setting mastic. Mastic applied on substrate in spot application, spacing and sizes as recommended by mirror manufacturer for use intended.

3.04 GLAZING INSTALLATION

A. General:
   1. Comply with glass fabricator’s recommendations.
   2. Install in accordance with glass and frame manufacturer's instructions.

3. Install plumb, level, square, true to line, and without warp or rack Provide all fasteners required for installation.
4. Except where curtain wall, window, entrance or glass manufacturer recommends otherwise, comply with Flat Glass Marketing Association (FGMA) Sealant Manual and FGMA Glazing Manual.
5. Material installed in a full bed of sealant, tooling finished surfaces smooth.
6. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
7. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
8. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

B. Glazing to fit line in rabbet with all edges straight and true. Size substantially as shown on the drawings, however Contractor shall fill sash and openings as actually constructed whether more or less than sizes given.

C. Do not apply glazing materials at temperatures below manufacturer's recommendations or to damp or frosted surfaces. Apply glazing material according to the manufacturer's instructions using proper primers as required.

D. Set glass using neoprene setting blocks and spacers to insure proper edge clearance and uniform beads of compound. Clearances shall conform to FGMA Glazing Manual requirements. Center glass in glazing rabbets.
1. Butt glazing requirements: Apply mildew resistant silicone sealant to flush depth of joint as indicated by sealant manufacturer.

E. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

F. Check openings to confirm proper clearance at perimeters and between glass and stops.
1. Clean surfaces of rabbet (including stops) and surface of glass which will come into contact with sealant. Use solvents and methods which insure clean, dry surfaces without film or foreign material when sealant is placed.

G. Remove and replace glazing beads carefully to avoid marking or defacing any portion of frame, sash, or fastenings.
1. Set glass in full bed of glazing tape or sealant. Clean glazing material after stops are installed. Clean excess compound, etc. from glass after setting in conformance with glass manufacturer's recommendations.
2. If recommended prime surfaces prior to glazing.

H. Set glass with reams (waves) running horizontally. Set glass with factory attached labels in place.

I. Setting Blocks: Place setting blocks at locations recommended by glass manufacturer, generally between 1/4 points and 6 inches from corner, except at glazed doors.
1. At glazed doors, provide one block at sill, located 3 inches up from edge of glass at hinge side; one block at hinge side jamb, located 3 inches up from lower edge of glass; one block at head, located 3 inches from edge of glass at latch side of door; and, one block at jamb at lock side of door, located 3 inches down from edge of glass at top corner.
2. Use blocks of length required to properly support glass. Offset approximately 1 inch from shims.

J. Glass Installation in Steel (Hollow Metal) Frames:
1. Glaze frames using pre-shimmed tape on both sides. Firmly glaze in place with joints sealed, free of rattles.

2. Set glass on setting blocks with a full bed of sealant or glazing tape.

K. Glass Installation in Aluminum Frames:
   1. Glaze aluminum frames using preformed EPDM elastomeric glazing extrusion separately or in combination with sealant and pre-shimmed glazing tape in compliance with aluminum frame supplier's recommendations.
   2. Set glass on setting blocks as recommended by manufacturer.
   3. Apply tape and/or sealant to produce uniform sight line even with frame.
   4. Set glass in gaskets with corners sealed.

L. Glazing Sealant: Along entire bottom edge of light, and up at least 6 inches at each jamb, gun in continuous full bed of sealant to fill voids.
   1. Fill entire space, full width of pane, full depth of glass, with sufficient sealant to form heel along inside face and edge of glass.
   2. At other edges (top and sides) gun in continuous heel bead of sealant along edges of glass perimeter to set stop against and into, acting as fill between glass and stop.
   3. Immediately after setting glass, at entire perimeter of glass, gun in sealant between stop and glass so space above spacer is completely filled, without voids.
   4. Place sealant flush with daylight edge of stops, with slight watershed at exterior. Provide straight, smooth surface meeting at opening corners with sharp intersection.
   5. Leave no sealant on exposed surfaces of stops and glass.

3.05 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.06 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.07 MIRRORS INSTALLATION

A. Mirrors installed using mirror glazing angles, concealed clips and mirror setting mastic. Mastic applied on substrate in spot application, spacing and sizes as recommended by mirror manufacturer for use intended.
   1. General Contractor shall coordinate with electrician to provide mirrored plates for outlets and switches installed in areas of mirror wall at workout room.

3.08 ADJUSTING AND CLEANING

A. Immediately after installation remove nonpermanent labels and clean surfaces.
   1. Clean excess sealant or compound from glass and framing members immediately after application, using solvents or cleaners recommended by manufacturers.

B. Glazing shall be protected from damage, and from contact with contaminating or harmful substances, during construction. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite protection measures, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
   2. Contractor shall assume all responsibility for breakage and shall replace cracked, broken, scratched or otherwise defective glazing.

C. Glazing shall be carefully cleaned at time of final acceptance, removing all non-permanent labels, excess sealant, paint and other foreign substances. Wash glass as recommended in writing by glass manufacturer.

3.09 GLASS SCHEDULE

A. Clear Float Glass: 1/4-inch; ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality-Q3 (glazing select).
   1. Application: at interior storefront system, and as indicated on drawings.

B. Clear Fully-Tempered Float Glass: 1/4-inch; ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality Q3 (glazing select), and heat-treated to comply with ASTM C 1048, Kind FT (fully tempered).
   1. Application: at interior storefront system, and as indicated on drawings.

C. 1" Insulated Glazing Units, fully-tempered where indicated and where required by code, tinted, Low-E:
   1. Basis of Design: Vitro Glazings (formerly PPG Ideascapes), Solarban 67.
      a. Tint Color: As selected by Architect.
   2. Configuration: 1-inch glazing units as follows:
      a. Outboard Lite: 1/4" thick, tinted glass with high performance Low-emissivity coated on No. 2 surface, Provide fully tempered where noted and where required by code.
      b. 1/2" air space**,** argon filled, with spacer as indicated in Part 2, Glass Products Article.
      c. Inboard Lite: 1/4" thick, clear glass with high performance Low-emissivity coated on No. 2 surface, Provide tempered where noted and where required by code.
   3. Visible Light Transmittance: Minimum 30% VT.
   4. Winter Nighttime U – Value: 0.50.
   5. Solar Heat Gain Coefficient: 0.25.
   6. Applications: Typical exterior glazing, including in doors.

D. 1" Insulated Spandrel glass: Viracon, Inc. or approved equal. Outboard lite tempered as indicated in drawings and where required by code. Color to be selected by Architect.

E. 1/4" Tempered glass, clear (used at interior wood doors and side-lites).

F. Unframed Plate Mirror: 1/4" thickness, tempered, laminated, ASTM C1503, Mirror Select Glazing Quality.
   1. Edge Treatment: Polished, rounded edges.
      a. At multiple pane mirror walls, apply edge treatment to perimeter only, with square butt edges between adjacent mirror panes.

END OF SECTION 08 80 00

SECTION 08 90 00 - LOUVERS & VENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Extent of louvers is indicated on drawing, including sizes and locations. Coordinate the size and locations with mechanical drawings and specifications. Provide complete attachments to substrates indicated.

B. Related Sections include the following:
   1. Division 04 Section - "Unit Masonry Assemblies".
   2. Division 05 Section - "Metal Fabrications", for masonry loose lintels and miscellaneous steel for louver attachment.
   3. Division 06 Section - "Wood Framing".
   4. Division 07 Section - "Air Barriers".
   5. Division 07 Section - "Joint Sealants".
   6. Division 07 Section - "Sheet Metal Flashing and Trim".
   7. Division 23 Mechanical, for mechanical wall louvers, ducts, dampers, and other adjacent construction.

1.03 QUALITY ASSURANCE

A. Performance Requirements: Where louvers are indicated to comply with specific performance requirements, provide units whose performance ratings have been determined in compliance with Air Movement and Control Association (AMCA) Standard 500.

B. Comply with SMACNA "Architectural Sheet Metal Manual" recommendation for fabrication, construction details and installation procedures, except as otherwise indicated.

C. Field Measurements: Verify size, location and placement of louver units prior to fabrication, wherever possible.

D. Coordination with Wall Openings: Verify final louver size includes required free area for model specified before creating rough opening in exterior material.

E. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. pre-assemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordination.

F. General Contractor shall ensure passive ventilated attic louvers (if applicable) and ducted mechanical louvers are sourced from a single manufacturer.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for required products, including finishes.

B. Shop Drawings: Submit shop drawings for fabrication and erection of louver units and accessories. Include plans, elevations and details of sections and connections to adjoining

work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements. Submit complete line of premium and standard color samples (12 colors minimum) for selection by Architect.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Horizontal Blade Aluminum Louvers:
   1. Typical louver in wall with masonry veneer, or CMU backup, unless noted otherwise: Stationary 6" deep frame, 37-1/2 degree blade angle and 5-15/16" vertical spacing, equal to Ruskin ELF6375DX, minimum 57% free area. Thickness not less than 0.081" for frames and extruded aluminum blades (Alloy 6063-T5). Provide bird screen and metal mesh insect screen.
   2. Typical louver in wall with siding, unless noted otherwise: Stationary 4" deep frame, 45 degree blade angle and approximately 4" vertical spacing, equal to Ruskin ELF445DX, minimum 50% free area. Thickness not less than 0.081" for frames and extruded aluminum blades (Alloy 6063-T5). Provide bird screen and metal mesh insect screen**.**
   3. Louvers under 1 SF in size: Stationary 2" deep frame, 45 degree blade angle and 2-7/16" vertical spacing, equal to Ruskin ELF211D, nominal 38% free area. Thickness not less than 0.060" for frames and extruded aluminum blades (Alloy 6063-T5). Primer shall be thermo-cured, 0.2 mil d.f.t. Finish shall be factory applied, high performance, fluorocarbon coating. Provide bird screen and metal mesh insect screen.
   4. Size louvers to sizes noted in Drawings, or to required open areas noted in Mechanical drawings and specifications, whichever is greater.
   5. Sill Flashing: Provide integral sill flashing or matching extended sill pan flashing that provides a 1-1/2” to 2” vertical turn down with drip edge at the exterior wall finish.
   6. Aluminum Louver Finish:
      a. Clear Anodized (Class I).
      b. Baked Enamel Fluoropolymer: Primer shall be thermo-cured, 0.2 mil d.f.t. Finish shall be factory applied, high performance, fluorocarbon coating. Color as selected by Architect from manufacturer's standard and premium colors.

B. Louver Screens: Provide frames consisting of U-shaped metal for permanently securing metal insect screen and bird screen mesh. Locate screens on inside face of louvers. Secure screens to louver frames with machine screws, spaced at each corner and at 12" o.c. between.

C. Fastenings: Fasteners for exterior applications may be hot-dip galvanized, stainless steel or aluminum.

D. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts. Furnish inserts, as required, to be set into concrete or masonry work.

2.02 FABRICATION

A. Provide louvers and accessories of design, materials, sizes, depth, arrangement, and metal thicknesses indicated, or if not indicated, as required for optimum performance with respect to airflow; water penetration; air leakage, where applicable (for adjustable units, if any); strength; durability; and uniform appearance.

B. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation including application of sealants in joints between louvers and adjoining work.

C. Include supports, anchorage, and accessories required for complete assembly.

D. Provide vertical mullions of type and at spacing recommended by manufacturer or 72" o.c., whichever is less. No intermediate.

E. Join Frame members to one another and to stationary louver blades by spline screwed, except where indicated otherwise or where field bolted connections between frame members are made necessary by size of louvers. Maintain equal blade spacing including separation between blades and frames at head and sill to produce uniform appearance.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for installation of anchorage which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.02 INSTALLATION

A. Locate and place louver units plumb, level and in proper alignment with adjacent work.

B. Use concealed anchorage wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.

D. Repair finishes damaged by cutting, welding, soldering and grinding operations require for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items which cannot be refinished in field to shop, make required alterations, and refinish entire unit, or provide new units, at Contractor's option.

END OF SECTION 08 90 00

SECTION 09 21 00 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide gypsum drywall as shown on the drawings and as herein specified including but not limited to: Metal stud framing, suspended ceiling systems, gypsum drywall and finishing systems.

B. Related Sections include the following:
   1. Division 6 Section “Rough Carpentry.”
   2. Division 6 Section “Wood Framing.”
   3. Division 6 Section “Architectural Woodwork", for coordination of metal framed cabinet supports.
   4. Division 7 Section “Thermal Insulation.”
   5. Division 7 for additional requirements for fire stopping and sealants installed with gypsum board assemblies.
   6. Division 9 Section “Metal Support Systems.”
   7. Division 9 Section “Acoustical Insulation.”
   8. Division 9 Section “Painting.”
   9. Division 9 Sections, for coordination of tiling, wall base materials, and other finishes applied to gypsum board assemblies.
   10. Divisions 10 and 11, and other Sections as applicable, for coordination of accessories and equipment requiring blocking in walls.

1.03 SUBMITTALS

A. Certificate: Furnish certificate evidencing that material meets or exceeds specification and fire rating requirement.

B. Samples: For the following products:
   1. Trim Accessories: Full-size sample 12 inches in length for each trim accessory indicated
   2. Textured Finishes: Provide mockup of texture finish for all finish levels and texture types indicated.

1.04 QUALITY ASSURANCE

A. Metal Support Standard: ASTM C754.

B. Metal Stud Standard: Fed Spec QQS-698 and QQS-775d, Class D.

C. Gypsum Board Standard: GA 216 by Gypsum Association.

D. Tolerances: 1/8" Offsets between planes of board faces and 1/4" in 8'-0" for plumb, level, warp and bow.

E. Gypsum Board Finish Mockups: Before finishing gypsum board assemblies, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and qualities of materials and execution.

1. Install mockups for the following applications:
   a. Surfaces indicated to receive adhered wall murals (Level 4 finish).
   b. Surfaces indicated to receive textured paint finishes.
2. Simulate finished lighting conditions for review of mockups.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 PERFORMANCE / DESIGN CRITERIA

A. Acoustic Ratings: Construct assemblies to achieve acoustic ratings indicated on Drawings, assemblies tested to ASTM E90 and classified in accordance with ASTM E 413 by an independent testing agency.

B. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by, and displaying a classification label from, an independent testing agency acceptable to the authority having jurisdiction.
   1. Construct assemblies to achieve fire resistance ratings indicated on Drawings, in accordance with applicable UL design numbers.
   2. In the event that requirements of assembly numbers referenced conflict with other Contract Document requirements, conform to assembly requirements.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials with manufacturer's label attached. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging. Protect materials from dampness or wetting. Remove any damaged materials.

B. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI's "Code of Standard Practice".

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Gypsum Board and Related Products:
      a. G-P Gypsum Corp.
      b. National Gypsum Company.
      c. United States Gypsum Co. (USG)

B. Source Limitations:

1. Provide wall board materials of each type and accessories used on the project by one manufacturer throughout.

2.02 FRAMING MATERIALS AND ACCESSORIES

A. Components, General: As follows:
   1. Comply with ASTM C 754 for conditions indicated.
   2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G40, hot-dip galvanized zinc coating.

B. Gypsum Board Ceiling Cold Rolled Main Runner Carrying Channels: 1-1/2", 16 gauge steel channels with minimum 1/2" wide flanges.

C. Cold Rolled Furring Channels: 3/4"**,** 1-1/2" and other Depths as indicated on Drawings, 16 gauge steel channels with minimum 1/2" wide flanges.

D. Hat Shape Furring Channels: ASTM C 645, 7/8" x 1-1/4" **,** minimum 22 gauge, galvanized steel hat shaped sections.

E. Resilient Furring Channels: 1/2" deep steel sheet members designed to reduce sound transmission.
   1. Configuration: Hat shaped.

F. Slide Clips: Provide minimum 600 pound lateral capacity design load thickness, or as shown on drawings. Provide prefabricated clips as manufactured by Clark Dietrich Framing Systems, or equal. Install as shown on drawings.

G. Framed openings: Galvanized steel one piece header and jamb studs meeting or exceeding the requirements of ASTM C 754.

H. Blocking and Backing Plates: Refer to Division 06, Section "Rough Carpentry". At Contractor's option, the following blocking types may be provided in lieu of fire rated wood blocking, provided that the material will meet the most stringent strength requirements for each item to be attached to such blocking.
   1. Proprietary fire-resistance-treated blocking and bracing in width indicated.

I. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.03 GYPSUM WALLBOARD PANELS

A. General: Specifications based on materials and manufacturers listed are to set quality standard. Subject to compliance with requirements, provide the named products, or comparable products by another manufacturer.

B. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

C. Gypsum Wallboard: ASTM C 1396 unless otherwise indicated.
   1. Type X:
      a. Thickness: 5/8" as indicated.
      b. Long Edges: Tapered.
      c. Location: Typical where other wallboard type is not otherwise indicated.
   2. Moisture and Mold Resistant: With moisture and mold resistant core and paper surfaces, mold resistance ASTM D 3273, score of 10 as rated according to ASTM D 3274.
      a. Thickness: 5/8".
      b. Long Edges: Tapered.

c. Location: At restrooms, apparatus bay ceilings, utility/laundry rooms, extractor, and similar wet and washable locations, except for backer board installed behind tile.

3. Shaft Wall: 1" Shaft Liner, with Type-S screws, or as required for fire rated assembly.

2.04 TILE BACKING PANELS

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325.

1. Products: Subject to compliance with requirements, provide one of the following or other approved equal:
   a. Custom Building Products; Wonderboard.
   b. United States Gypsum Co.; DUROCK Cement Board.
2. Thickness: As indicated.

2.05 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
   a. Cornerbeads: Equal to USG Dur-A-Bead. Use at outside corners.
   b. Metal Edge Trim: Standard trim of galvanized steel with either knurled and perforated or expanded flanges and beaded for concealment of flange in joint compound. Equal to USG 200 or 400 Series. Apply where board abuts or terminates at another material.
      1) L-Bead: L-shaped; exposed long flange receives joint compound; use at exposed panel edges.
      2) J-Mold: Metal J-molds; exposed flange receives joint compound, use at all panel edges abutting dissimilar materials.
   c. Gypsum Control Joints: Metal V-shape control joints. Use where indicated and at changes in backup material and in partitions at 30’-0” o.c. maximum, and at large gypsum board ceiling areas at 20'-0" o.c. maximum. Also provide at both sides all interior and exterior window & door frames.

B. Aluminum Trim: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy T-5. Extruded accessories of profiles and dimensions indicated in Drawings:

1. Profiles: Provide trims equal to Fry Reglet FDM-625-50 “F” Reveal, at in-plane CMU block wall to Gypsum Wall Board transitions (both horizontal and vertical), and as indicated elsewhere in drawings.
2. Finish: Clear Anodized

2.06 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.
   a. Use polymer-coated (alkali-resistant) mesh tape, 2” wide at interior applications, and 3” wide at exterior applications.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound, equal to USG Durabond 90.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound, equal to USG Durabond Joint Taping Compound.
3. Fill Coat: For second coat, use drying-type, all-purpose compound, equal to USG Ready Mixed Joint Topping.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:
1. Cementitious Backer Units: As recommended by panel manufacturer.

2.07 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
1. Laminating adhesive shall have a VOC content of 50 **<Insert value>** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Laminating adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Door frame Grout: Equal to USG Durabond 90 Joint Compound, Multi-Purpose.

D. Sealer Gaskets: 5-12" x 3/8" closed cell foam and adhesive backed peel and stick membrane, equal to Protecto Wrap (800-759-9727) "Triple Guard Energy Sill Sealer." Provide at all exterior studs in contact with floor slab.

E. Hanger Wire: ASTM A 641, 9 Gauge galvanized steel wire.

F. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

G. Insulation:
1. Thermal Insulation: Refer to Division 07, Section "Thermal Insulation".
2. Acoustical Insulation: Refer to Division 09, Section "Acoustical Insulation".
3. Fire Resistant Assemblies: Provide mineral fiber insulation according to the requirements of the fire rated assembly, except where greater thickness is indicated for partitions that also carry an acoustical rating.

2.08 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Non-Aggregate Finish: Pre-mixed, vinyl texture finish for spray application.
1. Texture: Light Orange Peel

PART 3 - EXECUTION

3.01 EXAMINATION AND COORDINATION

A. Examine areas and substrates including framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Immediately notify general contractor of any deficiencies in wood framing, especially at corridors, including but not limited to:
   1. Curved or out of plane sill plates, vertical studs, or wood ceiling framing/fur-downs.
   2. Warped and/or twisted studs
   3. Detached or loose studs and/or blocking
   4. Any other deficiencies that will produce a noticeable defect in the finished wall assembly after installation of gypsum wall board.

C. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

D. Interface and Coordination with Other Work:
   1. Coordinate installation of firestopping at penetrations through fire-resistive rated assemblies.
   2. Coordinate installation of joint sealers specified in Division 7 Section at penetrations of non fire-resistive rated assemblies.
   3. Coordinate support framing and blocking requirements of all construction to be attached to gypsum board assemblies.
   4. At partitions indicated to receive thermal or acoustical batts, pack insulation into cavities while framing is being fabricated for stud packs, box headers, and other framing cavities that will be inaccessible upon erection of framing.
   5. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
      a. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Main runner carrying channels attached to structure with hangar spacing as required to meet requirements of ASTM C 754, and other criteria as specified. Cross furring 3/4" channels attached to main runners.
   2. Deflection limited to 1/360 of span.
   3. Maximum allowable spacing of main runners, 48" O.C.; and cross furring 24" maximum O.C. At openings which interrupt main runners or furring channels, reinforce grille with 3/4" channels wire tied to and parallel to main runner channels.
   4. Maximum allowable spacing of hangers 48" O.C.
   5. Install uplift bracing to structure at exterior locations, air lock vestibules, Apparatus Bay**,** and at other spaces subject to wind uplift or sudden changes in air pressure.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   2. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards unless more stringent requirements are specified.
   4. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   6. Do not attach hangers to steel roof deck.
   7. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   8. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   9. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.03 INSTALLATION - PANEL ERECTION

A. General: Comply with ASTM C840.

B. Panel Installation:
   1. Use wallboard and sheathing of maximum lengths to minimize joints.
   2. Stagger end joints where they occur.
   3. Stagger vertical joints on opposite sides of partitions, and stagger joints between each layer of panel in multiple layer installations, by at least one framing member.
      a. Exception: Do not bridge panels over expansion joints.
   4. Locate end joints as far as possible from center of wall or ceiling.
   5. Do not place butt ends against tapered or grooved edges. Do not place tapered edges against cut edges or ends.
   6. Support ends and edges of wallboard on framing or furring members.
   7. No wallboard installed over piping, ducts, electric boxes or conduits until they have been installed, run and tested.
   8. Attach wallboard and sheathing with screws spaced 12" O.C. and staggered along abutting vertical edges.
   9. Exterior grooved sheathing installed horizontally with tongue up.
   10. Partitions indicated sealed to deck shall be continuous except where interrupted by structure, mechanical or electrical construction.

11. Fit gypsum panels around ducts, pipes, conduits, and structural members. Cut panels to fit profile of penetrations and apply a bead of sealant 1/4" to 3/8" wide.
12. Tape and float only is acceptable behind lockers that have solid backs unless otherwise required for partition fire or acoustical ratings.
13. Rated partitions shall have wall board continuous both sides above ceiling to deck and fire taped and sealed.
14. Partitions shown to include sound batt but not to extend to deck shall have wall board continuous to deck above ceiling and taped on one side only.
    a. Exception: Partitions shown to have acoustical insulation placed over ceiling to either side of the partition wall.
15. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, including floors and deck. Provide 1/4- to 1/2-inch wide spaces at these locations. Trim edges with edge trim where edges of panels will be exposed in the completed work. Seal joints between edges and abutting structural surfaces with acoustical sealant
16. Form control and expansion joints with space between edges of adjoining panels.

C. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

D. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

E. Wall Tile Substrate: ANSI A108.11
    1. Install tile backer board as substrate for thin set ceramic tile.
    2. Space 1/4" above fixture lips.
    3. Seal ends, cut edges and penetrations of each piece with water resistant compound before installation.
    4. Tape & mortar over all joints prior to tile installation.

F. Accessory Installation:
    1. Corner Beads: Install on external corners with suitable fasteners spaced 9" O.C.
    2. Metal Trim: Install over face layer with fasteners spaced 9" O.C. where shown and where gypsum surfaces meet dissimilar materials.
    3. Control Joint: Install control joints in locations where detailed, and the following, unless otherwise indicated:
        a. At changes in backup material.
        b. Vertically in partition walls at 30'-0" maximum on center.
        c. Horizontally in partition walls taller than 16'. Confirm elevations of such joints with Architect.
        d. In large ceilings 20'-0" maximum on center each way.
            1) Also at perimeter of ceilings in Apparatus Bay.
        e. At interior side of all exterior door and window frames.
        f. At both sides of all interior and exterior door and window frames.
    4. Aluminum Trim: Install in locations indicated in Drawings.

G. Joint Treatment Application:

1. Joint treatment compounds and products, as specified under Materials, shall be mixed and applied in accordance with manufacturer's direction to completely conceal all joints and screw depressions and provide a smooth surface to receive finishes as scheduled.

3.04 FINISH

A. Apply gypsum board finish in accordance with ASTM C 840, manufacturer's published instructions and GA-214 Finish Levels.
   1. Level 1: All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
      a. Application: In plenum areas above ceilings, in attics, in mechanical rooms, and in other areas where the assembly is generally concealed and not normally open to view. Accessories not required unless otherwise indicated or required by fire rated or acoustical rated construction.
         1) Where a fire resistance rating is required for the gypsum board assembly, details of construction shall be in accordance with reports of fire tests of assemblies that have met the fire rating requirement.
         2) Where acoustical rating requires more stringent finish application, comply with acoustical partition construction requirements.
   2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges and sand joints. Provide level 2 finish where panels are substrate for tile, behind plywood backer boards, in mechanical and electrical rooms, and where specifically indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
   3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface, and sand smooth. Provide Level 4 finish typical, where panels are to receive painted finish unless specifically indicated otherwise.
      a. Typical Texture for level 4 finish: Light orange peel texture, or other light texture as approved by Architect through sample and mockup review.
      b. Texture for level 4 finish at walls indicated to receive adhered sheet wall murals: Smooth.
   4. Level 5: All joints and interior angles shall have tape embedded in joint compound and three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges. Finished work free of noticeable defects which include joint ridging, staved joints, board edges damaged or out of place, joint blisters, nail pops, pinholes in joint treatment or any other noticeable defects. Finished work true to line, perfectly smooth and ready for painting or wall covering.
   5. Prepared surfaces shall be coated with a primer/sealer prior to the application of finish paint. Refer to specification Division 9 Section for painting.
      a. Application: For use where gloss semi-gloss, enamel, eggshell, or non-textured flat paints are specified or where severe lighting conditions occur. Generally in all areas except where noted otherwise.

3.05 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture matching approved mockup and free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

3.06 FIELD QUALITY CONTROL

A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
   1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
   2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
      a. Installation of 80 percent of lighting fixtures, powered for operation.
      b. Installation, insulation, and leak and pressure testing of water piping systems.
      c. Installation of air-duct systems.
      d. Installation of air devices.
      e. Installation of mechanical system control-air tubing.
      f. Installation of ceiling support framing.

3.07 PATCHING AND REPAIR

A. Remove and replace gypsum board panels that become wet, moisture damaged, or exhibit evidence of mold.

3.08 CLEANING

A. Contractor shall completely clean all areas affected by this work and shall leave no excess or scrap materials or bedding compound on the job site.

END OF SECTION 09 21 00

SECTION 09 22 26 - METAL SUSPENSION SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: Metal suspension support and framing components for interior and exterior gypsum wallboard, plaster and stucco ceilings and soffits.

B. Related Documents: The Contract Documents, as defined in Division 1 Section - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections include the following:
   1. Division 7 Section "Exterior Insulation and Finish System."
   2. Division 9 Section "Gypsum Wallboard."
   3. Division 9 Section "Plaster."
   4. Division 9 Section "Stucco."
   5. Division 9 Section "Acoustical Ceiling Suspension Members."

1.03 QUALITY ASSURANCE

A. Design Criteria:
   1. All suspended ceiling/soffit suspension systems installed so that deflection of finished surface does not exceed 1/360 of span.
   2. Exterior soffit supports and bracing designed and installed to withstand an I-90 uniform wind uplift loading condition.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original containers with brand or manufacturer's label attached. Protect metal materials from dampness or wetting. Store metallic materials and accessories indoors off floor.

PART 2 - PRODUCT

2.01 PRODUCTS

A. Carrying Channels: 1-1/2 inch 16 ga. galvanized steel channels with minimum weight of 475 lbs. per 1,000 lineal feet.

B. Furring Channels: 3/4 inch 16 ga. galvanized steel cold-rolled channels with minimum weight of 300 lbs. per 1,000 lineal feet.

C. Hat Channels at Gypsum Board Ceilings: 7/8 inch 25 ga. galvanized roll formed furring channels.

D. Tie Wire: 16 Ga. galvanized steel wire for tying channel iron to framing members.

E. Hangers: 8 Ga. galvanized annealed steel wire.

F. Metal accessories for EIFS or Stucco Soffits: 26 ga. galvanized as made by USG, Milcor or Fry.
   1. Corner Bead: USG No. 1A
   2. Bead: USG No. 66, 7/8".
   3. Control Joint: USG No. 75, USG No. 100
   4. Metal Trim: USG No. 200-A

G. Furring Channels: 7/8" Roll-formed hat-shaped section of minimum 25 gauge galvanized steel for use at gypsum panel ceiling.

H. Fasteners: 1" Type S screws.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Wire-tying:
   1. Splicing: Double wrap tie.
   2. Horizontal stiffeners to channel brackets: Figure eight tie.
   3. Framing members perpendicular to each other: Saddle tie.

B. Workmanship: Work erected in perfect condition, level plumb, true and rigid with all requisite bracing and stiffening members provided as required.

3.02 FURRING & SUSPENDED CEILINGS & SOFFITS

A. Attach hangers to structure at maximum 48" o.c. in direction of carrying channels and 36" o.c. in direction of cross furring and in accordance with manufacturer's instructions. Hanger design and spacing as required to meet design criteria. Hangers also installed within 6" of perimeter walls and ends of main runner channels.

B. Maximum allowable spacing of main runners, 48" O.C.; cross furring 12" O.C..

C. Furring securely wire tied and of ample strength to support required load without deflections exceeding design criteria. Do not continue furring continuous across control or expansion joints. Position and level carrying channel and saddle-tie securely with hanger wire.

D. Position 3/4" cross furring across carrying channels and saddle tie to carrying channels with three strands of 18 ga. tie wire.

E. Install vertical bracing as required for wind uplift loading, per I-90 requirements, or maximum 4'-0" o.c.e.w. Vertical bracing shall be 3-5/8" 18 gauge steel studs.

3.03 METAL ACCESSORIES

A. All openings, edges or where gypsum board edges terminate against dissimilar materials provide metal edges. Cornerites used at all junctions, corners, etc., unless otherwise noted. All exposed vertical and horizontal corners protected with corner beads.

SECTION 09 30 13 - CERAMIC TILING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Ceramic tile.
   2. Provide / replace tile to match existing historical tiles.
   3. Stone thresholds installed as part of tile installations.
   4. Crack suppression membrane for thin-set and medium set tile installations.
   5. Waterproof membrane for thick-set tile installations.
   6. Cementitious backer units installed as part of tile installations.
   7. Metal edge strips installed as part of tile installations.

B. Related Sections include the following:
   1. Division 03 Section "Cast-in-Place Concrete".
   2. Division 03 Section "Hydraulic Cement Underlayment".
   3. Division 07 Section "Joint Sealants" for additional quality standards for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
   4. Division 08 Section "Access Doors and Panels" for coordination with access doors and panels installation.
   5. Division 09 Section "Gypsum Board Assemblies" for cementitious backer units.
   6. Division 09 Section "Flooring" Sections for transition strips other than those specified in this Section.
   7. Division 10 Section "Toilet Accessories", and other sections as applicable, for coordination of recessed items installed in tiled walls.
   8. Division 22, for coordination with plumbing fixtures, shower base units, floor drains.

1.03 DEFINITIONS

A. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

B. Facial Dimension: Actual tile size (minor facial dimension as measured per ASTM C 499).

C. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

1.04 REFERENCE STANDARDS

A. TCA / TCNA: Tile Council of North America, Inc., and the TCNA Handbook for ceramic, glass, and stone tile installations, most current versions.

B. ANSI A108.01, Requirements for movement joints.

C. Marble Institute of America (MIA): Dimension Stone Design Manual for Expansion Joints.

D. ASTM C1242, Standard guide for selection, design, and installation of dimension stone attachment systems.

E. ASTM C1193, Standard guide for the use of joint sealants.

F. ASTM C1472, Standard guide for calculating movement and other effects when establishing sealant joint width.

1.05 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as tested per the DCOF AcuTest (ANSI A137.1):
   1. Level Surfaces: Minimum 0.42.

B. All sealants used in floor or traffic applications shall have a Shore A hardness not less than 35.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Initial Selection: For each type of tile indicated. Submit complete line of grout color for selection by Architect. Include Samples of accessories involving color selection.

D. Samples of existing-tile match: For color matching of existing tile, submit tile-matched samples of those original tiles that are part of the restorative work. Obtain Architects approval prior to ordering of all tiles for the project.

E. Samples for Verification:
   1. Full-size units of each type and composition of tile and for each color and finish required.
   2. Assembled samples with grouted joints for each type and composition of tile and for each color and finish required, at least 12 inches square and mounted on rigid panel. Use grout of type and in color or colors approved for completed work.
   3. Full-size units of each type of trim and accessory for each color and finish required.
   4. Stone thresholds in 6-inch lengths.
   5. Metal edge strips in 6-inch lengths.

1.07 INFORMATIONAL SUBMITTALS

A. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

B. Product Certificates: For each type of product, signed by product manufacturer stating products are suitable for intended application.

C. Qualification Data: For Installer.

D. Material Test Reports: For each tile-setting and -grouting product and special-purpose tile.

E. Letter from sealant manufacturer, stating suitability of products for each application indicated.

1.08 QUALITY ASSURANCE

A. Qualifications of Installers: For cutting, installing and grouting of ceramic tile, use only thoroughly trained and experienced journeyman tile setters who are completely familiar with the requirements of this work, and the recommendations contained in the referenced standards, and who are CTI, CTEF, ACT, or TCNA 5-Star TCCA Trowel of Excellence certified.

B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with the following:
   1. Grout and mortar setting shall comply with, ANSI A108.4 and ANSI A 108.5.
   2. Manufacture all ceramic tile in accordance with Standard Grade Requirements of ANSI 137.1.

3. Install all ceramic tile in accordance with the recommendations contained in Handbook for Ceramic Tile Installation of the Tile Council of North America, Inc., latest edition.

C. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
   1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

D. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

E. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
   1. Stone thresholds.
   2. Waterproofing.
   3. Joint sealants.
   4. Cementitious backer units.
   5. Metal edge strips.

F. Mockups: Build mockups to demonstrate aesthetic effects.
   1. Build mockup of each type of floor tile installation.
   2. Build mockup of each type of wall tile installation.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
   4. View mockup under permanent lighting conditions.

G. Where existing tile is to be color-matched, preserve as much existing tile as possible.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquid latexes and emulsion adhesives in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.10 WARRANTY

A. Provide 10-year labor and material Warranty.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.12 MAINTENANCE MATERIALS

A. Furnish extra materials that are from same production runs as products installed, that match products installed, and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
   2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The following requirements apply for product selection:
   1. Basis-of-Design Product: The design for each tile type is based on the product named. Subject to compliance with requirements, provide either the named product or an approved comparable product by another manufacturer.

2.02 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
   2. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.

C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the specified product:

D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

E. Warpage: No more than one-tenth the length of the measured span of the tile can exhibit more than 25 percent of total allowable warpage.

2.03 TILE PRODUCTS

A. Available Suppliers whose products may be incorporated into the work include but are not limited to the following:
   1. As scheduled for new tile.

B. Wall Porcelain Tile: Glazed porcelain ceramic tile. Size and type as indicated on drawings.

C. Floor Tile: Porcelain tile. Size and type as indicated on drawings.

D. Trim & Special Tile: Provide necessary caps, stops, coves, returns, trimmers, and other shapes as required for a complete installation. Items to be supplied by the same manufacturer supplying the tile.

E. Patio Grill Station Countertop: Large format Porcelain tile countertop, size and type as indicated in drawings.

F. Ceramic Tile: Flat tile as scheduled on drawings.

G. Cap Tile at half-height wall: Provide custom cap tile with rounded edges, to match adjacent glazed tile.

2.04 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
   1. Bevel edges at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2 inch or less, and finish bevel to match face of threshold.

B. Stone Thresholds: ASTM C 615 with honed finish.
   1. Stone or Marble: In thicknesses as required for installation indicated in part 3 and as detailed in Drawings. Uniform, fine to medium-grained stone or marble in color as selected by Architect. Bevel edges at 1:2 slope. Align lower edge of bevels with adjacent floor finishes.
      a. Where a stone threshold is indicated for 3'x5' handicap accessible showers, provide threshold without any bevel and sized for flush installation.

2.05 CRACK ISOLATION MEMBRANE FOR THIN-SET FLOOR TILE INSTALLATIONS

A. Basis of Design Products: Design is based on products indicated. Subject to compliance with requirements; provide one of the named products, or an approved equal substitution.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
   1. Crack Isolation Membrane: ANSI A118.12:
      a. Custom Building Products;. Fracture-Free Crack Isolation Membrane Waterproofing and Crack Prevention Membrane.
      b. Laticrete; Blue 92 Anti-Fracture Membrane, Hydro Ban.
      c. MAPEI; Mapelastic CI, Mapelastic AquaDefense.
      d. Custom Building Products; Custom 9240.
      e. TEC; HydraFlex.

2.06 WATERPROOFING MEMBRANES FOR THICK-SET TILE INSTALLATIONS

A. Basis of Design Products: Design is based on products indicated. Subject to compliance with requirements; provide one of the named products, or an approved equal substitution.

B. Fabric-Reinforced, Fluid-Applied Product: System consisting of liquid-latex rubber and fabric reinforcement.
   1. Waterproofing Membrane: ANSI A118.10:
      a. LATICRETE International, Inc.; Laticrete 9235 Waterproof Membrane.
      b. Custom Building Products; Custom 9240.
      c. MAPEI; Mapelastic 400 Waterproof Membrane.

2.07 WATERPROOFING FOR THIN-SET TILE INSTALLATIONS

A. General: Manufacturer's standard product that complies with ANSI A118.10, selected from the following;

B. Waterproofing Membrane (Concrete Slabs).
   1. Flexible load-bearing, self-curing liquid rubber polymer and reinforcing fabric to form a seamless, heavy-duty waterproof membrane below a protective surface. Provide continuously under floor tile and behind wall tile:

a. Laticrete; “9235”, Hydroban.
b. MAPEI; Mapelastic 400, Mapelastic AquaDefense.
c. Custom Building Products; Custom 9240
d. TEC; HydraFlex.

2. Provide reinforcing membranes at floor to vertical surfaces, throughout shower pan and wall lining to the full height of the wall tile, and for other conditions as recommended by Manufacturer for the waterproofing system indicated.
3. At curbless shower installations, extend membrane 1'-0" beyond shower enclosure.

C. Waterproofing and Uncoupling Membrane (Wood or Plywood Deck).
1. Flexible polyethylene membrane with grid structure of square dovetail cavities, with anchoring fleece laminated to the underside.
a. Schluter “Ditra”, as manufactured by Schluter-Systems L.P., Plattsburgh, NY (800) 472-4588.
b. Laticrete “Strata_Mat”, as manufactured by Laticrete International, Inc., Grand Prairie, TX (972) 641-3266.

2.08 WATERPROOFING SYSTEM FOR TILE SHOWER APPLICATIONS

A. Waterproofing system: Provide complete shower waterproofing system for shower pan and wall waterproofing, consisting of 8 mil thick polyethylene membrane with bonded fleece on both sides. Membrane shall meet or exceed the requirements of "American National Standard Specifications for load bearing, bonded, waterproof membranes for thin-set ceramic tile and dimension stone installation A118.10", shall be listed by cUPC, and shall be evaluated by ICC-ES for compliance with local building code requirements. Subject to compliance with requirements, provide Schluter Kerdi system, or approved equal:
1. Waterproofing membrane: Schluter Kerdi**,** Kerdi-DS system at steam rooms or steam showers.
2. Seaming membrane: Schluter Kerdi-BAND.
3. Waterproofing Accessories: Schluter Kerdi-SEAL mixing valve and pipe seals.
4. Provide pre-formed corner pieces at all intersections of planes, and as required for complete waterproofing system.
5. Provide sealants as recommended by Manufacturer for complete installation.
6. Kerdi-Board-SN for tiled soap and shower shelf: Size: 12"x12" soap and shampoo single shelf.
7. At curbless shower installation, extend membrane 1'-0" beyond shower enclosure.

2.09 SETTING MATERIALS

A. Setting Materials Quality, General: Standards and materials specified herein are to set a minimum acceptable quality standard for setting materials. Contractor may, at Contractor's option and without change in price, propose to provide a higher grade of setting materials that may in Contractor's opinion reduce labor costs, reduce setting time, or afford other benefits in installation. Include for Architect's consideration the reasons for any such proposed revisions of setting materials with product submittal.

B. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   1. Custom Building Products.
   2. LATICRETE International Inc.
   3. MAPEI Corporation.

C. Portland Cement Thickset Mortar Installation Materials: ANSI A108.02.
   1. Thickset Bed Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.

D. Latex-Polymer Modified Portland Cement Mortar (Thin Set) for Wall and Floor: ANSI A118.4, consisting of the following:
   1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at Project site. Available products include the following:
      a. MAPEI; Ultraflex 2, Ultraflex 3.
      b. Custom Building Products; VersaBond Flex.
      c. Laticrete; 253 Gold, 254 Platinum.
   2. For wall applications, provide mortar that complies with requirements for non-sagging mortar, ISO 13007; C2TE, in addition to the other requirements in ANSI A118.4.
   3. For thin-set application of large format tiles, use LHT mortar.

E. Dry-Set Mortar for Large and Heavy Tile (LHT) large format tile at Patio Grill Station countertop: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 3/32" to 1/2".
   1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
      a. MAPEI; Ultraflex LFT.
      b. Custom Building Products; Natural Stone and Large Tile Premium Mortar.
      c. Laticrete; 4-XLT.
   2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
      a. MAPEI; Kerabond / Keralastic.
      b. Custom Building Products; Custom Blend / Custom Flex.
      c. Laticrete; 315 / 333.
      d. MAPEI; Ultraflex LFT Rapid.
      e. Custom Building Products; MegaLite RS.
      f. Laticrete; 254 Rapid.

2.10 GROUT MATERIALS:

A. Ready-to-Use, Non-Staining Grout: Pre-Mixed Non-Staining Professional-grade, ready-to-use color consistent quartz aggregate grout, for use with grout joints 1/16” to 1 /2” (1,5 to 12 mm) and complying with ANSI A118.6, ANSI A118.7, and ISO 13007; CG2.
   1. Available Products:

a. MAPEI; Flexcolor CQ.
b. Custom Building Products; Fusion Pro.
c. Laticrete

2.11 ELASTOMERIC SEALANTS

A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 7 Section "Joint Sealants."

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
   1. Where Grout Manufacturer's sealants meet requirements throughout, use Grout Manufacturer's matching color sealants for sealant joints between tiles. Available Products:
      a. MAPEI; Mapesil.
      b. Laticrete; Latasil.
      c. Custom Building Products; Commerical 100% Silicone Caulk.
   2. Other Available Products may include:
      a. Dow Corning Corporation; Dow Corning 786.
      b. GE Silicones; Sanitary 1700.
      c. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
      d. Tremco, Inc.; Tremsil 600 White.

D. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.
   1. Available Products:
      a. MAPEI; Mapeflex P1 SL.
      b. Bostik; Chem-Calk 550.
      c. Mameco International, Inc.; Vulkem 245.
      d. Pecora Corporation; NR-200 Urexpan.
      e. Tremco, Inc.; THC-900.

E. Joint Backers: Foam joint backer material to prevent sealant bond and form recommended joint cross sectional shape. Round or rectangular with rounded top, and in sizes as appropriate to joint sizes and conditions.

2.12 CEMENTITIOUS BACKER UNITS

A. Provide 5/8” cementitious backer units at all walls to receive tile and on top of plywood subfloor/deck to receive waterproofing and tile All walls in wet areas complying with ANSI A118.9 in maximum lengths available to minimize end-to-end butt joints re: Division 09 Section “Gypsum Board Assemblies.”

2.13 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Metal edge strips with flange for embedding in tile setting material. Provide shapes as noted below, in sizes to match tile and setting-bed thickness and adjacent

finish materials at transitions. Subject to compliance with requirements, provide metal strips as manufactured by Schluter**,** or other approved equal.

1. Ceramic Tile to Concrete, LVT**,** or other lower floor material: "RENO-U" by Schluter. Finish: Clear anodized aluminum.
2. Top edges of tile (that do not go to ceiling): "QUADEC" by Schluter. Finish: Clear anodized aluminum.
3. Tile Outside Corners: "QUADEC" by Schluter. Finish: Clear anodized aluminum. Include universal accessory pieces for inside and outside corners, and end caps.
4. Wall tile base to floor tile: "DILEX-AHK" by Schluter. Finish: Clear anodized aluminum.
5. Inside Corners shall be soft tile sealant joints to match grout color.
6. Shower System Trim: Provide trim pieces as indicated:
   a. Thresholds at open side of 3'x3' transfer showers: Stone Threshold, with 1/4" projection above tile surface outside of the shower and 1/2" maximum top of threshold to tile surface inside the shower Thresholds shall be a maximum of 1/2" height in compliance with ADA and Texas Accessibility Standards.
7. Porcelain Tile Countertop Edges: “RONDEC-STEP” by Schluter. Finish: Clear anodized aluminum.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

A. Grout (and Un-glazed porcelain tile) Sealer: Manufacturer's standard grade silicone product for sealing grout joints that does not change color, sheen, or appearance of grout.
   1. Available Products:
      a. MAPEI Corporation; Ultracare Penetrating Tile, Stone, and Grout Sealer.
      b. Custom Building Products; Aquamix Penetrating Sealer.
      c. C-Cure; Penetrating Sealer 978.

2.14 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
   2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
   3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Contractor shall apply leveling coat or dry-set mortar over wall and floor surfaces which may vary more than 1-inch in 10 feet. Installation constitutes acceptance of the substrate.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Where existing tile is to be color-matched, preserve as much of the existing original tile installation as possible. Remove only damaged, discolored or mismatched tile, or previous patches of inferior quality

3.02 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

B. Provide concrete substrates for tile floors, installed with adhesives or thin-set mortar that complies with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
   1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.
   2. Remove protrusions, bumps, and ridges by sanding or grinding.

C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
   1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
      a. Tile floors in wet areas.
      b. Tile floors composed of tiles 8 by 8 inches or larger.
   2. Comply with ANSI standards for tolerances except as follows:
      a. Lippage: Lippage at floor and wall tile shall not exceed 1/32" between adjacent tiles.
      b. Unless specifically noted otherwise in Drawings, where tiles of different gage thickness are installed adjacent to each other on the same surface, install with thicker medium set mortar bed at the thinner tile as required to install surfaces of adjacent tiles flush, to within the maximum allowed tile lippage.

B. TCNA Installation Guidelines: TCNA's "Handbook for Ceramic Tile Installation." Comply with TCNA installation methods indicated in ceramic tile installation schedules.

C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile

fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.

F. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints per approved shop drawings, and in compliance with TCNA handbook recommendations where indicated during installation of settings materials, mortar beds, and tile. Do not saw-cut joints after installing tiles. Do not allow grout, setting materials, or other hard materials to restrict movement or bridge across at movement joints.
   1. Install sealant materials per manufacturer's installation instructions and industry standards. Clean and prime surfaces as recommended by manufacturer. Do not exceed temperature limitations, including where required shading of joints until after cured where joints are exposed to direct sunlight.
   2. Locate joints at inside corners, in tile surfaces directly above joints in concrete substrates, and per reference standards.
   3. Prepare joints and apply sealants to comply with requirements of Division 7 Section "Joint Sealants."
   4. Install movement joints with appropriate joint backer material.
   5. Install movement joints per details in TCNA EJ171, except where pre-fabricated joint profiles are indicated.
   6. Sealant profile shall be slightly concave.

G. Grout tile to comply with requirements of the following tile installation standards:
   1. For ceramic tile grouts (sand-portland cement; dry-set, commercial portland cement; and latex-portland cement grouts), comply with ANSI A108.10.
   2. For chemical-resistant epoxy grouts, comply with ANSI A108.6.

H. Where indicated, install cementitious backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.04 ANTI-FRACTURE AND WATERPROOFING MEMBRANES INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer’s written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.

B. Install water proofing membrane under and behind floor tile and turned up 9" vertical behind wall tile in all restrooms.
   1. At showers, install waterproofing system throughout the shower including behind wall tile, and extend waterproofing system behind adjacent tile at least 9" beyond the shower on all sides.

C. Install Anti-Fracture membrane at all floor tile not otherwise indicated for waterproofing membrane installation.

D. Shower Waterproofing System Installation: Install in strict compliance with Manufacturer's current technical literature and installation instructions. Install complete waterproofing system over entire shower pan and walls and extend 9" behind adjacent tile beyond all edges of the shower. Install with special reinforcing shape pieces at intersections of planes and at plumbing penetrations per Manufacturer's installation instructions.

E. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.
   1. Stop up shower drains and flood shower pans to test waterproofing to be leak-free for minimum of 24 hours duration, or greater where required by authorities having jurisdiction, prior to tile installation.

3.05 FLOOR TILE INSTALLATION

A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCNA installation methods and ANSI A108 Series of tile installation standards.
   1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
      a. Tile floors composed of tiles 8 by 8 inches or larger.

B. Joint Widths: Install tile on floors with the following joint widths:
   1. Ceramic Tile: 1/8”
   2. Unless otherwise approved by Architect, accurately cut tile to install with joint widths between tile and floor drains, floor sinks, and similar items in floors, to the same joint widths as in the tile field.

C. Tile Pattern: As indicated in Drawings.

D. Stone Thresholds: Install stone thresholds at restroom entries and where called for in Drawings; set in same type of setting bed as abutting field tile, unless otherwise indicated.
   1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent non-tile floor finish.
   2. Install thresholds in compliance with Texas Accessibility Standards or local handicap accessibility code having jurisdiction.
      a. At doorways or transitions to adjacent flooring, install threshold with 1:2 beveled edges, set with top of threshold 1/8" to 1/4" above adjacent tile floor and not more than 1/2" total height above lowest adjacent flooring. Bottom of beveled edges should be flush to 1/16" above adjacent flooring surfaces unless otherwise detailed in Drawings.
      b. Where a stone threshold is indicated for 3'x3' handicap accessible showers, install threshold with 1:2 beveled edges, set between 3/8" to 1/2" vertical height above the lowest adjacent flooring.
      c. Where a stone threshold is indicated for 3'x5' handicap accessible showers, install non-beveled threshold flush with the shower floor tile or pan. Float the floor up between 1% min. to 2% max. as required to provide slope back to the shower drain. There shall be no curb at the flush transition.

E. Metal Edge Strips: Provide at locations other than restrooms where exposed edge of tile flooring meets carpet, wood, vinyl composition tile, or other flooring that finishes flush with top of tile. Install with setting flanges embedded in the tile setting material.
   1. Use full length pieces to the extent possible in order to minimize the number of joints.
   2. Unless otherwise noted, install edge strips flush with faces of tile to within maximum lippage tolerances as specified for tile.

F. Top Sealers: Apply top sealers to tiles and grout according to sealer Manufacturer's written instructions. Wipe to remove excess sealer within time limits indicated by Manufacturer to avoid films or residues.

G. Grout Sealers: Apply grout sealer to cementitious grout according to grout-sealer Manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.06 WALL TILE INSTALLATION

A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCNA installation methods and ANSI setting-bed standards.

B. Joint Widths: Install tile on walls with the following joint widths:
   1. Ceramic Tile: 1/8 inch**.**

C. Tile Pattern: As indicated in Drawings.

D. Coved and Base Tile: Where special shaped coved or base tile is indicated, install special shaped tiles with the toe of the cove properly aligned with adjacent floor tile and the face of the tile properly aligned with adjacent wall tile to within tolerances indicated, to within the maximum tolerances specified for tile lippage at both surfaces.
   1. Where use of metal cove trim is indicated, install coved metal trim pieces to comply with above requirements for coved tile, and requirements for metal trim strips.
   2. At junctions of cove bae tile with floor tile, ensure cove base is not recessed relative to adjacent floor tile in a manner that would trap water deeper than the allowed lippage.
   3. Where cove base is available with outside corner pieces, provide and install outside corner pieces at all outside corners. Otherwise, neatly miter cove tile at corners.
   4. Install adjacent pieces at inside and outside corners to within the maximum lippage as specified.

E. Metal Trim Strips: Install at all locations indicated or as required to conceal exposed edge of tile:
   1. Use full length pieces to the extent possible in order to minimize the number of joints.
   2. Unless otherwise noted, install edge strips flush with faces of tile to within maximum lippage tolerances as specified for tile.
   3. Install all strips and transitions set in mortar beneath tile, and per manufacturer's instructions.
   4. At top of tile wainscots and other exposed edges of wall tile, install caulk joint between metal trim and wall. Do not grout to wall. Coordinate color with Architect and adjacent finishes.
   5. Metal Trim at Showers: Install according to Manufacturer's instructions and as follows:
      a. Unless otherwise detailed in Drawings, the open side of handicap accessible showers should be installed with metal trim edge creating a sloped lip 1/4" (minimum) to 1/2" (maximum) in total height, and compliant with ADA and Texas Accessibility Standards (TAS). Install trim at open side of shower flush with floor tile, and the low side of the trim flush with sloping tile inside the shower pan.
      b. Install adjustable rake trim at rake sides of shower, with face of trim flush with wall tile above.
      c. Install trim at low, slot drain side of shower with the top of trim aligned with the adjacent rake trim pieces.

3.07 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.08 FLOOR TILE INSTALLATION SCHEDULE

A. Tile Installation: Interior floor installation on concrete; thin-set mortar on crack isolation membrane; TCNA F125-Full.
   1. Locations: Typical where floor tile is indicate, unless otherwise noted.
   2. Thin-Set Mortar: Latex-portland cement mortar.
   3. Grout: Ready-to-use, Non-staining Grout.

3.09 WALL TILE INSTALLATION SCHEDULE

A. Tile Installation W244C: Interior wall installation over cementitious backer units; thin-set mortar; TCNA W244C.
   1. Location: As indicated at locations other than showers.
   2. Thin-Set Mortar: Latex-portland cement mortar.
   3. Grout: Ready-to-use, Non-staining Grout

3.10 SHOWER WALL INSTALLATION SCHEDULE:

A. Tile Installation B422: Thin-set mortar on waterproof membrane over cementitious backer units/fiber cement underlayment with integrated bonding flange for bonded membranes; TCNA B422.
   1. Location: Tile Showers.
   2. Thick-Set Portland Cement Mortar at recessed floor conditions.
   3. Thin-Set Mortar: Latex-modified portland cement mortar.
   4. Grout: Ready-to-use, Non-staining Grout.

END OF SECTION 09 30 13

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide acoustical ceilings as shown on the drawings and as herein specified.

B. Related Sections include the following:
   1. Division 09 Section - Non-Structural Metal Framing.
   2. Division 09 Section - Metal Support Systems, Gypsum Board Assemblies, for gypsum board ceilings support system.
   3. Division 21 through 28 Mechanical and Electrical Sections, for coordination with devices installed in grid ceilings.

1.03 QUALITY ASSURANCE

A. Fire Hazard Classification: Maximum flame spread, Class A (less than 25) as tested in accordance with ASTM E-84 and per Fed. Spec. SS-S-118a.

1.04 SUBMITTALS

A. Product Data: Manufacturer's product specifications and installation instructions for each acoustical ceiling material required, and for each suspension system, including certified laboratory test reports and other data as required to show compliance with these specifications.

B. Samples: Set of 4" x 4" square samples for each acoustical unit required, showing full range of exposed color and texture to be expected in completed work.

1.05 COORDINATION

A. Contractor shall coordinate connection of lighting and electrical devices to grid. Where lighting fixtures are provided with integral clips, install lighting fixture with the clip attachments and not with screws through grid tees.

PART 2 - PRODUCTS

2.01 CEILING TILE AND GRID

A. Acoustical Panels:
   1. Type ACT1: 24" x 24" x 5/8" mineral fiber tile made for a lay-in grid suspension system. Panel design is Armstrong "Dune", Color: White. Use fire rated ceiling tile and protected light fixtures in areas noted on plans.
      a. Use with Grid Type 1.

B. Wood Ceiling Planks: Linear acoustic wood ceiling made for metal suspension system. Panel design is Armstrong Woodworks Linear Veneered Planks, for custom stain color to be selected by Architect.
   1. Veneer Species and cut: Custom (stained to match millwork).

2. Size: 3/4” x 3-1/2” x 96” planks, spaced with 3/4" reveal.
3. Accessory: Perimeter Angle Molding (Black finish)
4. NRC: 0.45
5. Fire Resistance: Class A (UL)
6. VOC Formaldehyde: None Added.
7. Suspension Requirements: Use Linear Carriers provided by Armstrong suited for WoodWorks Linear planks.

C. Lay-in suspension system: Exposed steel members made for use with panel types specified. System supplied with all main runner tees, cross tees, wall angles, clips, connectors, fastening and hangar wires. Subject to compliance with requirements, provide the named products below:
1. Grid Type 1: Grid to be 24" x 24" pattern with white finish. Armstrong’s “Suprafine ML” 9/16” exposed tee, or approved equal.

2.02 MISCELLANEOUS MATERIALS

A. Uplift Bracing and Retention Clips: Provide uplift bracing and retention clips designed to prevent tiles from dislodging due to wind or air pressure changes at exterior grid, grid in airlock vestibules, and in similar locations subject to wind or sudden changes in air pressure.
1. Provide retention clips at all plank type tile as recommended by Manufacturer.
a. Equal to Armstrong Universal Hold-Down clip for typical air pressure uplift locations unless otherwise recommended.
b. Spring Retention Clip: Equal to Armstrong #414, for where universal clips are inadequate.

B. Eggcrate Lens & Grid: Plastic eggcrate with 1/2" x 1/2" x 1/2" cubes molded of translucent white acrylic. The louvers shall have a uniform appearance in the continuous row and shall include edge angle and cross grids, color white.
1. Locations: <Insert where used>.

C. Edge Treatment for cut edges of tegular and grooved edge ceiling tiles and planks: Manufacturer's recommended touch up paint.

D. Provide any additional trims for Woodworks Linear plank suspended ceilings as recommended by manufacturer to complete the work as indicated in the drawings, including but not limited to accessories for trimming out cut-outs for light fixtures, concealed sprinkler heads, speakers, and HVAC diffusers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ceiling grids and acoustical panels completely installed in all areas indicated. Ceiling plenum shall be completely enclosed from adjoining conditioned space by structure, partitions, and/or acoustical panels.

B. Suspension systems installed by direct suspension from structural systems in accordance with manufacturer's specification. Hanger wire shall support no greater than 16 square feet. Install additional hangars at ends of each suspension member, at each end of light fixtures, and 6 inches from vertical surfaces. Do not splay wires more than 5 inches in a 4 foot drop. Bottom of surfaces shall be flush and level. Miter corners where wall moldings intersect.

C. Install grid with uplift bracing and retention clips where required.

D. The plumbing and heating contractors shall not utilize hangers or framing of suspension system. The electrical contractor may utilize suspension system for lay-in fixture installation but shall furnish two supplementary hangers per fixture for maintaining maximum load deflection. Electrical contractor shall not utilize tile as sole support for any ceiling-mounted electrical device. All ceiling-mounted electrical devices shall be supported with brackets attached to tees.

E. Ceilings laid out as shown on the drawings, however, if not specifically shown, ceilings laid out from center of room in both directions so that cut tiles are equal at all edges. Place materials to have full bearing on suspension members.

F. Where there are cut edges at tegular tile, or other tile with profile below the grid, touch up cut edges as recommened by Manufacturer with Manufacturer's recommended touch-up paint. Where cut edges are next to a wall and will not be visible, touch up paint is not required. Do not apply touch-up paint on the face of ceiling tile.

G. Prior to wood plank ceiling installation, General Contractor and ceiling installer shall coordinate all cut-out locations and sizes for various trades in suspended wood ceiling, and should treat that ceiling as architectural woodwork with a high level of craftmanship expected as a finished product. Damaged wood planks and irregular, over-cut, or mis-placed cut-outs will be rejected by the Architect and will be required to be replaced at no cost to the Owner.

H. Install ceiling planks so that light fixture penetrations are either centered in planks, and rows of light fixtures aligned in one or both directions when applicable. Refer to drawings for intended fixture placement. Coordinate all other penetrations from various trades in a way that shall minimize cutting of planks.

I. Where there are cut or exposed dges at wood ceiling planks, conceal edges with compatible trim products as recommended by manufactuer. If trimming edges is not possible, touch-up/stain edges as recommended by manfuactuer.

J. To minimize delays and/or errors in the Work, the General Contractor may schedule a pre-installation conference between various related trades and Architect prior to installation of suspended wood plank ceiling.

3.02 INSPECTION

A. Following installation, soiled or discolored units cleaned to match adjacent perfect material. Any broken or damaged material which cannot be corrected by cleaning, removed and replaced with perfect material.

END OF SECTION 09 51 00

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide all resilient flooring materials with accessories as shown on the drawings and as herein specified.
   2. All areas of new construction and all renovated areas shall receive vinyl composition tile flooring and new base per these specifications, unless scheduled or noted otherwise.

B. Related Sections include the following:
   1. Division 9 Section “Carpet.”

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Materials delivered to job site in manufacturer's unopened containers with labels intact. Store materials at minimum temperature of 70°F in all areas for at least 48 hours prior to installation.

1.04 JOB CONDITIONS

A. Environmental Requirements: Maintain temperature of 70°F in all areas for at least 48 hours before, during and after installation. Maintain a temperature of 60°F after installation.

1.05 SUBMITTALS

A. Submit the following samples of each type, color, and pattern of resilient flooring and accessories required, showing full range of color and pattern variations.
   1. 12” x 12” sheet flooring samples
   2. 2-1/2' long samples of resilient flooring accessories.

1.06 QUALITY ASSURANCE

A. Tile, Mastic and all other materials shall be asbestos free.

B. Install resilient floor tiles in accordance with the recommended method of the "Tile Contractors Association of America Handbook".

C. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.07 EXTRA MATERIALS

A. Provide the following, for each color and type installed, for future replacement:
   1. Sheet Flooring: 5% of installed quantity, provided as one continuous uncut roll.
   2. Vinyl Transition Mouldings: 10% of installed quantity, provide as one single piece, or full length pieces as applicable.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sheet rubber flooring: As indicated in drawings.

B. Transitional Moulding (Sheet to Sheet): No. 166 as manufactured by Mercer Products Co. or approved equal.

C. Transitional Moulding (Sheet to 0"): No. 177 as manufactured by Mercer Products Co., or approve equal.

D. Adhesive: Waterproof, stabilized type as recommended by material manufacturer for each specific product and for its area of use. Leveling material as specifically recommended by material manufacturer.

E. Leveling Compound: Latex type as specifically recommended by material manufacturer.

F. All materials best grade, with no second grade, off goods or remnants allowed.

PART 3 - EXECUTION

3.01 INSPECTION

A. All surfaces receiving resilient flooring material shall be examined by the installer for any defects which in his opinion, he considers detrimental to a proper installation. Concrete floors dry and free of dust and laitance. Any defects found during inspection must be corrected prior to installation; this includes any sanding, brushing or leveling required. Installation constitutes acceptance of substrate conditions.

3.02 INSTALLATION

A. Clean all surfaces of grease, dirt, paint and other objectionable matter. Fill and level any holes, cracks, joints and depressions in substrate with leveling material. Provide backer material if necessary.

B. Flooring and accessories installed in strict accordance with manufacturers printed instructions.

C. Lay sheets with close joints, fit neatly into recesses and around abutting work. Sheet shall be cemented securely and solidly in place. Use various sheet widths as required to minimize joints. No transverse joints in hallway/corridors Finished surfaces true in plane and flush throughout.

D. At places where flooring terminates, provide vinyl reducing edge strips.

E. At transitions between floor types provide appropriate molding accessory. Mouldings at corners shall be mitered.

F. At places where flooring abuts a vertical surface without cove base or at floor transitions, sheet shall be cut evenly and without a gap between the sheet and adjacent surface.

3.03 PROTECTION AND CLEANING

A. Protect floors with un-dyed, untreated Kraft paper immediately after placement. Traffic should be kept off for at least 8 hours. No heavy equipment or scaffolding should be dragged over the floor.

B. Resilient sheet flooring shall be cleaned and waxed with manufacturer's recommended cleaner and given 2 coats of non-slip water emulsion wax in accordance with manufacturer's recommendations. Upon completion, floor must present a clear waxed finish with a glossy surface. Rubber base shall also be cleaned removing all adhesive or other defects.

C. Resilient sheet flooring shall be carefully cleaned by damp mopping, minimally one week following installation.

END OF SECTION 09 65 00

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Resilient base.
   2. Resilient molding accessories.

B. Related Sections:
   1. Division 09 Section “Gypsum Board.”
   2. Division 09 Section “Tiling.”
   3. Division 09 Section “Sheet Carpeting.”
   4. Division 09 Section “Resilient Tile Flooring.”

1.03 SUBMITTALS

A. Comply with pertinent provisions of Division 01 “Submittal Procedures”, unless otherwise indicated.

B. Product Data: For each type of product indicated.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples, of each resilient product color, texture, and pattern required.

E. Product Schedule: For resilient products.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.05 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F in spaces to receive resilient products during the following time periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 60 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rubber Base: Base 2000™ Wall Base by FLEXCO®, complying with ASTM F 1861, Type TP, Group 2, Styles B. "Cove" profile, 1/2" thick by 4" tall, with Inside and Outside corners with nominal 3" return by FLEXCO®. Cove base at all flooring. Color as shown on drawings.

B. Adhesive: Waterproof, stabilized type as recommended by material manufacturer for each specific product and for its area of use. Leveling material as specifically recommended by material manufacturer.

C. All materials best grade, with no second grade, off goods or remnants allowed.

2.02 RESILIENT MOLDING ACCESSORY

A. Resilient Molding Accessory:
   1. Manufacturers: Subject to compliance with requirements, provide the following:
      a. FLEXCO®.

B. Description: Transition strips as required between carpet and LVT plank flooring.

C. Material: Rubber.

D. Colors and Patterns: As indicated on drawings.

2.03 INSTALLATION MATERIALS

A. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
   1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

B. Cove Base Adhesives: Not more than 50 g/L.
   a. Rubber Floor Adhesives: Not more than 60 g/L.

2.04 RESILIENT RUBBER STAIR TREADS

A. Manufacturer: FLEXCO®.

B. Test Results:
   1. F2169 Standard Specification for Resilient Stair Tread –Type TS
   2. F386 Standard Test Method for Thickness of Resilient Flooring Materials having flat surfaces.

C. One-Piece Tread and Riser:
   1. Color and Pattern: As indicated on drawings.
      a. Complies with ASTM F2169, Type TS, Class 2 (Patterned).
      b. Length: As indicated on drawings.
      c. Depth: 20 ½" nominal from inside of nose.
      d. Thickness: ¼" nominal tread portion, riser tapers.
      e. Nose Length: 1 9/16".
      f. Nose thickness: ¼".
      g. Tapered nose: Yes.
      h. Relief cut: Yes.
      i. Limited year warranty: manufacturer's limited wear warranty of five years for heavy traffic.

D. Rubber Stringers
      a. Height: As indicated on drawings.
      b. Thickness: .100" nominal.
      c. Length: 72" nominal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are same temperature as the space where they are to be installed.
   1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.03 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible.

3.04 RESILIENT STAIR TREAD INSTALLATION

A. Refer to manufacturer for detailed specifications on installation of resilient Stair Treads, Risers and Stringers with regard to job site conditions, substrate testing and preparation, adhesive and trowel selection and application, layout and installation, seam treatment, clean up and protection of new stair treads after installation.
   1. Install with manufacturer's recommended Adhesive only.
   2. Use Epoxy Caulking Compound as a nose filler on all stair treads
   3. Use matching Colored Caulk as needed to fill gaps
   4. All stair tread, stringers and risers backings must first be thoroughly cleaned with a clean white cloth and denatured alcohol before applying adhesives, Quik-Stik Adhesive Tape or Epoxy Caulking Compound.
   5. Special stair tread, stringer & riser backing preparation must be followed when utilizing Quik-Stik Adhesive Tape.

3.05 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet that would otherwise be exposed.

3.06 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 65 66 - ATHLETIC RUBBER FLOORING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 DESCRIPTION

A. Scope:
   1. Installation of prefabricated rubber sports flooring, dual durometer vulcanized and calendared, including adhesive.

B. Related Specifications
   1. Division 3 Section “Concrete.”

1.03 QUALITY ASSURANCE

A. Acceptable manufacturer.
   1. Firm experienced in the manufacturing of prefabricated rubber surfacing.

B. Acceptable Installer
   1. Installer must submit a list of similar projects completed within the past three years.

C. Installer to be recognized and approved by the sport surfacing manufacturer.

D. Provide mock-up of 6’ x 6’ to be evaluated by Architect prior to proceeding.

1.04 SUBMITTALS

A. Submit samples of the actual sport surface in the standard colors.

B. Submit three copies of each of the following:
   1. Manufacturer’s requirements for correct preparation, finishing and testing of substrate base material to receive premanufactured rubber sport surface.
   2. Interior or exterior adhesive product data sheets an manufacturers certificates indicating approval for the proposed application.
   3. Interior and exterior line paint data sheets and manufacturers certificates indicating approval for the proposed application.
   4. Manufacturer's standard warranty.
   5. Manufacturer's installation and maintenance instructions.

1.05 DELIVERY AND STORAGE

A. Deliver and store material in the original containers with seals unbroken and labels intact, in a maintained environment of minimum of 55°, and below 5% relative humidity. Flooring, if in squares, not to be stacked more than two pallets high. Protect work until accepted by owner.

PART 2 - PRODUCTS

2.01 PREFABRICATED RUBBER SURFACE

A. RF2: Prefabricated rubber sport flooring to be ECOfit 8,2mm thickness, smooth embossed pattern, as manufactured by Ecore Commercial. Color as indicated on drawings. Prefabricated rubber surface to be calendared and vulcanized with a base of natural and synthetic rubber, stabilizing agents and pigmentation. Provide material in 6'-0" rolls.

2.02 ADHESIVE

A. Rubber sport surface adhesive to be two part polyurethane or epoxy adhesive suitable for adherence of a goods to concrete substrate. Adhesive to be supplied by the surface manufacture.

2.03 ACCESSORIES

A. Transition Moulding (to LVT plank): "700 Imperial Reducer - 5/16" manufactured by Mercer, or approved equal. Trim to butt join LVT plank.

PART 3 - EXECUTION

3.01 GENERAL

A. Concrete substrate to be in place a minimum of thirty days prior to the installation of the rubber athletic flooring. Maximum of 3% moisture content in the substrate (CM Test.) Preparation of substrate to provide a smooth, dense finish highly compacted with a tolerance of 1/8″ in a 10′ radius.

B. All inserts, penetrations and other construction items which affect the installation of the prefabricated rubber sport surface to be in place.

C. Rubber sports surface installer to approve field conditions.

D. Deficiencies in substrate to be corrected prior to installation.

3.02 INSTALLATION

A. Install prefabricated rubber sports surface in accordance with the latest manufacturer's recommendations. Installation by a certified contractor.

B. Rubber sport surface to be unrolled left to relax and precisely fit prior to adhesion.

C. Mix adhesive in accordance with manufacturers instructions. Adhesive to be spread with an 1/8 or 1/6″ notched trowel.

D. Hold all seams in place with suitable weights for a minimum of 12 hours.

END OF SECTION 09 65 66

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Perform all work required to complete the Carpeting indicated by the Contract Documents and all work that can be reasonably inferred to be included. Furnish all supplementary items necessary for its proper installation.

B. Related Sections include the following:
   1. Division 09 Section “Resilient Base and Accessories”, for rubber base.
   2. Division 09, floor finish Sections, for transition with adjacent flooring systems not covered in this Section.

1.03 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's complete technical product data for each type of carpet, cushion and accessory item required. Indicate installation pattern and other options.

B. Samples:
   1. Four full-size carpet tiles of each pattern and color tile specified, exhibiting full color range of the carpet.
   2. 12" long sample of each accessory item.

C. Maintenance Instructions:
   1. Carpet manufacturer shall give a written maintenance outline to the Owner for proper care of the installed material. This shall include type of cleaning apparatus to use, type of cleaning agent required and material supplier's address and phone.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver all materials to the project properly protected taking care not to damage any materials.

1.05 JOB CONDITIONS

A. Environmental Requirements: Temperature of rooms in which carpeting is to be installed shall be properly maintained at adhesive manufacturer's recommended levels.

B. Field Measurements: All dimensions are approximate and the Contractor shall be responsible for verifying all dimensions and conditions in the field prior to installation.

1.06 CONTRACTOR QUALIFICATIONS

A. The Contractor shall be experienced in the supervision of carpet installation, with at least five (5) years experience in this type of work. The actual work shall be done by qualified

and experienced mechanics working under his supervision or under the supervision of an experienced workroom supervisor who has also been doing this type of work for five years.

1.07 WARRANTY

A. Manufacturer's standard form, limited lifetime commercial warranty.

1.08 EXTRA MATERIALS

A. Provide 10% of installed quantity as attic stock for future replacement, of each color and pattern indicated.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The following products/manufacturers are acceptable:

As scheduled in the Drawings.

2.02 MATERIAL

A. Carpet: Provide material of construction, material, weight, and aesthetic and other properties and performance factors equal to or exceeding scheduled products, as approved by Architect, and as follows:
   1. Static control below 3.5 K.V.
   2. Class I.
   3. Flammability meeting NFPA-253 and ASTM-E648 (.45 watts/cm2).
   4. Smoke density meeting NFPA-258 - 450 or less.
   5. Color and Pattern: As indicated on Drawings.
   6. Tile Size: 18" x 36"

B. Adhesive: Waterproof type recommended in writing by carpet manufacturer to suit this application and expected service.

C. Edge Strips: Rubber butting gauge shall be Mercer's #EG-XX-B in color to match base, or approved equal.

D. Carpet Reducer: Rubber reducer #CRS-XX of height equal to carpeting, and other accessories as made by Mercer, or approved equal. Colors as selected by the Architect from manufacturer's standards.

E. Carpet Tile Adapter: Rubber tile adapter equal to Mercer's #CTA-XX-A of color as selected by Architect from manufacturer's standards.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. The carpet manufacturer's recommended procedures for installation shall be closely followed. Particular attention is to be paid to recommendations for application of floor covering adhesive, and seams.

B. Carpet edgings shall be neatly trimmed for tight fit along walls, cut and fit evenly around all projections and into trim strips. Fit closely and evenly to, in and through doorways, terminating carpet under doors. Finished installation shall be smooth and free of ripples and puckers.

C. Carpet binder bar shall be supplied and installed as required at doorways and other openings adjoining hard surface materials. Secure with nails appropriate for substrate.

D. All carpet shall be laid in quarter turn pattern, unless specifically shown otherwise.

E. Spots and smears of floor covering adhesive and seam cement shall be removed immediately.

F. Perform initial vacuum cleaning of entire installation and leave in clean condition.

3.02 INSPECTION AND PREPARATION

A. Contractor shall inspect substrate before starting his work. Any objectionable conditions shall be brought to the attention of the Contractor. Any high ridges, excessive gaps or other items must be repaired prior to installation. Contractor shall apply leveling material over uneven or rough surfaces.

B. Do not proceed with work until defects are corrected. The Contractor shall check all dimensions and other conditions in area of work, and shall be responsible for proper fitting of carpet in areas designated.

C. Before installation, remove debris and job soiling with a vacuum and damp mop.

D. The application or installation of carpet by the contractor constitutes acceptance of substrate.

3.03 FLOOR INSTALLATION

A. Install carpet using direct glue method in accordance with carpet manufacturer's recommendations.

B. Carpet shall be installed in largest possible pieces. Center carpet layout for equal size pieces at edges.

C. Check carpet before beginning installation and ensure there are no visible variations between dye lots.

D. Cut and fit neatly around projections through floor and to walls or other vertical surface, leaving no gaps. Hardware items mounted to the substrate shall be removed and reinstalled following carpet installation.

E. All edges shall be free from fraying. On all finished edges where carpet abuts an adjacent floor at the same or different level, finishing strips must be applied as specified. Finishing edges shall be mechanically fastened to substrate.

F. Metal edge moldings shall be mitered at corners and mechanically fastened to substrate at 12" O.C. minimum. Do not fasten through carpet. Tap downs shall be installed without denting.

G. Carpet installation shall be unwrinkled, without twist, laid tight and flat to subfloor, well adhered, and present a uniform appearance. Ensure color, pattern and texture match within any one area.

H. Carpet step-off saddle and reducer strips shall be supplied and installed at doorways, where carpeting abuts dissimilar floor surfaces.

I. Do not place heavy objects such as furniture on carpeted surfaces for minimum of 24 hours or until adhesive has set.

J. Carpet which wrinkles or loosens at tile edges within one year from date of installation shall be corrected at no cost to the Owner.

3.04 CLEAN-UP

A. After carpet installation is complete, remove all remnants, wrapping paper and debris. Neatly trim all sprouting tufts with sharp scissors. The Owner shall view all carpet scraps and retain any as designated for future repairs, before they are removed from the job site. These scraps shall be in addition to attic stock or maintenance material specified.

B. All carpet shall be vacuumed and left protected in a manner ready for occupancy.

END OF SECTION 09 68 13

SECTION 09 81 00 - ACOUSTICAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide sound insulation as shown on the drawings and as herein specified.

B. Related Sections include the following:
   1. Division 07 Section "Thermal Insulation."
   2. Division 07 Section "Joint Sealants", and Division 09 "Gypsum Board Assemblies", for acoustical sealants and other acoustical components used in partition wall assemblies.

1.03 PERFORMANCE REQUIREMENTS

A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

B. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency
   1. Batt Insulation: flame spread and smoke developed of 0. NFPA 101 Class A.
   2. Other insulation types: As indicated.

C. Low VOC: All batt insulation products shall be made with binder containing no added urea formaldehyde.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original packages, clearly marked with brand name, type and R-Value.

B. Store materials in area protected from weather, moisture and damage, remove any damaged materials from the site.

1.05 SUBMITTALS

A. Samples of materials and complete product and technical description submitted for approval to the Architect prior to ordering materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from fiberglass, slag wool, or rock wool. Unfaced batt insulation, 3-1/2" thick, with an R-Value of 15.
   1. STC-Rated Acoustical Assemblies: Comply with acoustical rating assembly requirements.

2. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

B. Sound Insulation Batts above Lay-In Ceilings: 3-1/2", unfaced batt insulation with an R-Value of 15, of same type as wall batts.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas receiving insulation work to insure work of preceding trades is completed. Check surfaces to see that they are uniform in place, free from mortar droppings, grease, oil or other debris which would affect proper insulation. Application constitutes acceptance of substrate conditions.

3.02 INSTALLATION

A. Insulation installed in accordance with current printed recommendations of insulation manufacturer.

B. Install sound batts tightly to studs and to all penetrations. Install tightly fitted and continuously behind and around conduit, boxes, pipe, and other obstructions. Install in full length pieces in each stud cavity to the extent possible to minimize the number of joints at cut ends. Fit cut ends pressed together to ensure a continuous acoustical barrier. Where the stud depth is greater than the nominal batt thickness, cut ends in mats shall be overlapped at least two inches.

END OF SECTION 09 81 00

SECTION 09 91 00 - PAINTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Provide complete surface preparation, priming, field painting and sealing of exposed exterior and interior items and surfaces.
   1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
   2. Examine specifications for various other trades and their provisions regarding their painting. Surfaces that are left unfinished by other sections of specifications shall be painted or finished as a part of this section.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
   1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

C. Do not paint prefinished items and finished metal surfaces except where otherwise noted in Drawings or specifications. Do not paint concealed surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Architectural woodwork.
      b. Acoustical wall panels.
      c. Toilet enclosures.
      d. Metal lockers.
      e. Elevator entrance doors and frames.
      f. Elevator equipment.
      g. Finished mechanical and electrical equipment.
      h. Light fixtures.
      i. Zinc wall panels
      j. Prefinished wall, roof & soffit panels
   2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
      a. Foundation spaces.
      b. Furred areas.
      c. Ceiling plenums.
      d. Pipe spaces.
      e. Duct shafts.
      f. Elevator shafts.
   3. Finished metal surfaces include the following:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.

d. Copper and copper alloys.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:
   a. Valve and damper operators.
   b. Linkages.
   c. Sensing devices.
   d. Motor and fan shafts.
5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:
1. Division 5 Section "Structural Steel" for shop priming structural steel.
2. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.
3. Division 7 Section "Joint Sealers ".
4. Division 8 Section "Steel Doors and Frames" for factory priming steel doors and frames.
5. Division 9 Section "Gypsum Board" for surface preparation of gypsum board.
6. Division 32 Section "Pavement Accessories" for traffic-marking paint.

1.03 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.04 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.
1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
3. Submit 3 samples on the following substrates for Architect's review of color and texture only:
   a. Masonry: 6-by-10-inch samples of masonry, with mortar joint in the center, for each finish and color. (Field installation acceptable).
   b. Painted Gypsum Board: 8-inch-square samples for each color and material on hardboard.
   c. Ferrous Metal: 4-inch- square samples of flat metal and 8-inch-long Samples of solid metal for each color and finish. (Field installation acceptable).

C. Qualification Data: For Applicator.

D. The Contractor shall furnish the Owner with a booklet of actual samples of the colors used on the project at project completion.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.
   1. Architect will select one room or surface to represent surfaces and conditions for application of each type of coating and substrate.
      a. Wall Surfaces: Provide samples on at least 100 sq. ft.
      b. Small Areas and Items: Architect will designate items or areas required.
      c. Portion of all wood to be finished or restored, including windows, doors, frames, rails, etc.
   2. Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.
      a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
   3. Final approval of colors will be from benchmark samples.

D. Wood Sealer: Shall meet Fed. Spec. TT-W-572B for water repellence.

E. Materials shall be manufacturer's best grade of respective paint types.

F. Gloss levels for paints required are as per the National Paint and Coatings Association.

G. Prior to acid-etching of the concrete floor and application of the epoxy coating, an on-site conference of the applicator, contractor, Architect and manufacturer's representative shall review proper installation procedures.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at an ambient temperature between 45 and 95 deg F, or as recommended by manufacturer, whichever is most stringent. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.07 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
   1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

D. Provide adequate ventilation of spaces while applying primer and finish coats.

E. All application of coatings shall be done under adequate illumination.

1.08 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
   1. Quantity: Furnish Owner with an additional 3 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

C. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Kelly-Moore Paint Co. (Kelly-Moore).
   2. Sherwin-Williams Co. (Sherwin-Williams).
   3. As approved by Architect.

2.02 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
   1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the

exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: Match Architect's samples.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 CONCRETE UNIT MASONRY BLOCK FILLERS

A. Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.
   1. Kelly-Moore; 521 Fill and Prime Acrylic Block Filler: Applied at a dry film thickness of not less than 10.0 mils.
   2. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.

2.04 EXTERIOR PRIMERS

A. Exterior Ferrous-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.
   1. Kelly-Moore; 1711 Kel-Guard Alkyd White Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils.
   2. Sherwin-Williams; Pro-Cryl Universal Primer B66-310 Series: Applied at a dry film thickness of not less than 3.0 mils.

B. Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.
   1. Kelly-Moore; 5725 DTM-Acrylic Metal Primer: Applied at a dry film thickness of not less than 1.8 mils. Where recommended by manufacturer.
   2. Sherwin-Williams; Pro-Cryl Universal Primer B66-310 Series: Applied at a dry film thickness of not less than 3.0 mils.

C. Exterior Primer for existing ceramic coated sheet metal: Sherwin-Williams B51- 450 Interior/Exterior Multi-Purpose Latex "Adhesion Primer", or approved equal. Applied at a dry film thickness of 1.4 mils.
   1. Adhesion Primer must be topcoated within 14 days of primer application.

D. Exterior Primer for Wood without knots: Sherwin-Williams Exterior Latex Wood Primer B42W8041. Applied at dry film thickness of not less than 1.4 mils.

E. Exterior Primer for Wood containing knots: Sherwin-Williams Exterior Oil-Based Wood Primer Y24W8020. Applied at at dry film thickness of not less than 2.3 mils.

F. Exterior Primer for Concrete and Fiber Cement Siding (Hardi Board): Loxon Concrete & Masonry Primer B24W8300: Applied at a dry film thickness of not less than 3.0 mils.

G. Exterior Primer for Drywall: Sherwin-Williams B51- 450 Interior/Exterior Multi-Purpose Latex "Adhesion Primer", or approved equal. Applied at a dry film thickness of 1.4 mils.

H. Exterior Architectural PVC, Plastic, or Fiberglass: Sherwin-Williams B51- 450 Interior/Exterior Multi-Purpose Latex "Adhesion Primer", or approved equal. Applied at a dry film thickness of 1.4 mils.

2.05 INTERIOR PRIMERS

A. Interior Concrete Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.
   1. Kelly-Moore; 971 Acry-Prime Interior Latex Primer/Sealer: Applied at a dry film thickness of not less than 1.6 mils.
   2. Sherwin-Williams; Loxon Concrete & Masonry Primer B24W8300: Applied at a dry film thickness of not less than 3.0 mils.

B. Interior Masonry Primer: 100% acrylic-emulsion conditioner for interior application only, to bond light chalk to the surface of existing brick & CMU.
   1. Sherwin-Williams; Loxon Conditioner Masonry Primer A24-1100 Series: Applied at a dry film thickness per manufacturer's recommendation.
   2. No substitutions

C. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.
   1. Kelly-Moore; 971 Acry-Prime Interior Latex Primer/Sealer: Applied at a dry film thickness of not less than 1.6 mils.
   2. Sherwin-Williams; ProMar 200 Zero VOC Latex Wall Primer B28W2600 Series: Applied at a dry film thickness of not less than 1.5 mils.

D. Interior Plaster Primer: Factory-formulated latex-based primer for interior application.
   1. Kelly-Moore; 247 Chem-Guard Acrylic Masonry Primer: Applied at a dry film thickness of not less than 1.9 mils.
   2. Sherwin-Williams; ProMar 200 Zero VOC Latex Wall Primer B28W2600 Series: Applied at a dry film thickness of not less than 1.5 mils.

E. Interior Plaster Primer at inside plaster face of all exterior walls: Factory-formulated latex-based primer for interior application.
   1. Sherwin-Williams; High Build Primer Latex Wall Primer B28W8601 Series: Applied at a dry film thickness of not less than 3.0 mils.
   2. No substitutions.

F. Interior Wood Primer for Full-Gloss Alkyd-Enamel Finishes: Factory-formulated alkyd- or acrylic-latex-based interior wood primer.
   1. Kelly-Moore; 985 Flo-Cote Alkyd Enamel Undercoater: Applied at a dry film thickness of not less than 2.5 mils.
   2. Sherwin-Williams; Premium Wall and Wood Interior Latex Primer B28W8111 Series: Applied at a dry film thickness of not less than 1.8 mils.

G. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.
   1. Kelly-Moore; 1711 Kel-Guard Alkyd White Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils.
   2. Sherwin-Williams; Pro-Cryl Universal Primer B66-310 Series: Applied at a dry film thickness of not less than 3.0 mils.

H. Interior Zinc-Coated Metal Primer: Factory-formulated galvanized metal primer.
   1. Kelly-Moore; 1722 Kel-Guard Acrylic Galvanized Iron Primer: Applied at a dry film thickness of not less than 1.8 mils.

2. Sherwin-Williams; Pro-Cryl Universal Primer B66-310 Series: Applied at a dry film thickness of not less than 3.0 mils.

2.06 EXTERIOR FINISH COATS

A. Exterior Full-Gloss Acrylic Enamel for Ferrous and Other Metals (Lintels, Trim, Partitions, and wainscot): Factory-formulated full-gloss waterborne acrylic-latex enamel for exterior application.
   1. Benjamin Moore; Moore's IMC Acrylic Gloss Enamel M28: Applied at a dry film thickness of not less than 2.0 mils.
   2. Coronado; 80 Line Rust Scat Acrylic Latex High Gloss Enamel: Applied at a dry film thickness of not less than 1.4 mils.
   3. ICI Dulux Paints; 3028-XXXX Dulux Interior/Exterior Acrylic Gloss Finish: Applied at a dry film thickness of not less than 1.6 mils.
   4. Kelly-Moore; 5780 DTM Acrylic Gloss Enamel: Applied at a dry film thickness of not less than 1.7 mils.
   5. Pittsburgh Paints; 90-300 Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels: Applied at a dry film thickness of not less than 3.0 mils.
   6. Sherwin-Williams; Pro Industrial Acrylic Gloss B66-600 Series: Applied at a dry film thickness of not less than 2.5 mils.

B. Exterior Semi-Gloss Acrylic Enamel for Ferrous and Other Metals: (Lintels, Trim, Partitions, and wainscot): Factory-formulated semi-gloss waterborne acrylic-latex enamel for exterior application.

   Sherwin-Williams; Pro Industrial Acrylic Semi-Gloss B66-650 Series: Applied at a dry film thickness of not less than 2.5 mils.

C. Exterior Wood, Cement, or Brick Flat Finish: Sherwin-Williams A-100 Exterior Latex Flat, A6-100 Series. Applied at a dry film thickness of not less than 1.2 mils.

D. Exterior Wood, Cement, or Brick Satin Finish: Sherwin-Williams A-100 Exterior Latex Satin, A82-100 Series. Applied at a dry film thickness of not less than 1.5 mils.

E. Exterior Textured Coating: Sherwin-Williams Ultra Crete Medium Textured Coating, A44W811. Applied at 50-80 sq. ft/gal.

F. Exterior Metal Canopy Semi-Gloss Sherwin-Williams SprayLastic Exterior Semi-Gloss Waterborne Dryfall, B42W17/B42T17. Applied at a dry film thickness of not less than 2.0 mils.

G. Exterior Stained Wood Semi-Transparent: Sherwin-Williams WoodScapes Exterior Polyurethane Semi-Transparent Stain, A15T5.

2.07 INTERIOR FINISH COATS

A. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application: ProMar 200 Zero VOC Interior Latex Flat. Applied to a dry film thickness of not less than 1.6 mils.

B. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel: Promar 200 Zero VOC Interior Eg-Shel. Applied to a dry film thickness of not less than 1.7 mils.

C. Interior Semi-Gloss Acrylic Enamel: Factory-formulated semigloss acrylic-latex enamel for interior application.
   1. Kelly-Moore; 1649 Acrylic-Latex Semi-Gloss Enamel: Applied at a dry film thickness of not less than 1.7 mils.

2. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Semi-Gloss Enamel B31-2600 Series: Applied at a dry film thickness of not less than 1.6 mils.

D. Interior Full-Gloss Acrylic Enamel: Factory-formulated full-gloss acrylic-latex interior enamel.
   1. Kelly-Moore; 1680 Dura-Poxy Gloss Acrylic Enamel: Applied at a dry film thickness of not less than 1.6 mils.
   2. Sherwin-Williams; Solo 100% Acrylic Interior/Exterior Gloss: Applied at a dry film thickness of not less than 1.6 mils.

E. Interior Full-Gloss Alkyd Enamel for Wood and Metal Surfaces: Factory-formulated full-gloss alkyd interior enamel.
   1. Kelly-Moore; 1630--Kel-Cote Interior Alkyd Semi-Gloss Enamel: Applied at a dry film thickness of not less than 2.2 mils.
   2. Sherwin-Williams; ProMar 200 Alkyd Gloss Enamel B35-200 Series: Applied at a dry film thickness of not less than 1.5 mils.

F. Interior Full Gloss Epoxy:
   1. Sherwin-Williams; Tile-Clad High Solids Epoxy B62Z series: Applied at a dry film thickness of not less than 2.5 mils.

G. Interior Precatalysed Water-Based Epoxy:
   1. Sherwin-Williams; Pro Industrial Pre-Catalysed Water-based Epoxy K45-150 Series (Egg-shell): Applied at a dry film thickness of not less than 1.5 mils.
   2. To be installed at (previously painted) interior existing brick and CMU surfaces; and interior plaster surfaces of exterior walls.

H. Interior DryFall, Water Based Flat, for Galvanized Steel Decking: Sherwin-Williams Pro Industrial Waterborne Acrylic Dryfall B42W81.

2.08 INTERIOR WOOD STAINS AND VARNISHES

A. Interior Oil Stain: Sherwin-Williams Wood Classics Oil Stain A49-200 Series, or comparable.
   1. Color: As Indicated on Drawings.

B. Clear Sanding Sealer: Factory-formulated fast-drying alkyd-based clear wood sealer applied at spreading rate recommended by manufacturer. Use sanding sealer as may be required to reduce quantity of stain soaked in by porous woods such as cedar, and/or to achieve approved color and effect as approved by sample and mockup reviews specified in other sections.
   1. Kelly-Moore; 2164 E Z Sand Alkyd Q. D. Sealer.
   2. Sherwin-Williams; Wood Classics Fast Dry Sanding Sealer B26V43.

C. Interior Alkyd- or Polyurethane-Based Clear Satin Varnish: Factory-formulated alkyd- or polyurethane-based clear varnish.
   1. Kelly-Moore; 2050 Kel--Aqua Stain Base.
   2. Sherwin-Williams; Wood Classics Fast Dry Oil Varnish, Satin A66-300 Series.

2.09 MISCELLANEOUS PAINT PRODUCTS

A. Epoxy: Two component epoxy coating shall be Sherwin-William's "Tile-Clad High Solids Epoxy #B62Z Series, or approved equal.

B. Semi-transparent water repellent wood preservative stain shall be Olympic's Semi-Transparent Oil Base Stain, or equal.

C. Other materials such as linseed oil, turpentine and shellacs shall be pure and of highest quality.

D. Acrylic Concrete Coating: Exterior concrete coating shall be "Thorocoat" 100% acrylic, textured coating as manufactured by Thoro System Products, Miami, Florida. Color as selected by Architect.

E. Concrete Floor Sealer: Exposed concrete floor slabs with smooth troweled finish: One coat flood-applied, hardener/densifier. Chemical reactive silicate / siliconate formulation that enhances sheen level of troweled concrete and is designed to mainatin or increase sheen level over time with normal wear. Provide one of the following or approved equal product by another Manufacturer:
   a. Euclid Chemical Company; "Euco Diamond Hard", www.euclidchemical.com.
   b. CureCrete Chemical Company; "Ashford Formula", www.ashfordformula.com.
   c. Dayton Superior; "Sure-Hard Densifier J17", www.daytonchemical.com.
   d. L&M Construction Chemicals: "Seal Hard", www.lmmc.com.

F. Epoxy Coating: Interior concrete block to receive coating shall be filled using a modified epoxy masonry filler equal to Tnemec's No. 54-660 and receive epoxy-polyomide coating equal to Tnemec's Series 66 HiBuild Epoxoline.

G. Exterior Concrete Block Protective Coating: One part, water based, cross linked copolymer coating shall be Rainguard Products Company's "Vandl-Guard Graffiti Resistant Coating", or approved equal.

H. Concrete Block Sealer: Waterproofing clear penetrating sealer shall be "Rainguard XS" as manufactured by Rainguard Products Co., or approved equal. Install at coverage rate determined adequate by manufacturer's representative.

I. Sealer Thinner: Sonneborne's "Reducer 990", or approved equal.

J. Wood Sealer: Penetrating water-repelling sealer shall be Olympic, "Water Guard".

K. Waterbased Epoxy: Catalyzed epoxy meeting requirements of ASTM D3730, equal to Sherwin Williams B67 Series.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.
   1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.02 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers, or remove and re-prime.
   2. Cementitious and Masonry Materials: Prepare brick, concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
      a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
      b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
   3. Wood: Clean new or existing surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view down to consistent substrate for intended finish. Ensure smooth surface remains and remove all residual dust.
      a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
      b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, trim, rails, doors, frames and windows.
      c. If transparent finish is required, backprime with spar varnish.
      d. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
   4. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
      a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
      b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
   5. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
   1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
   2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
   3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Concrete floor surfaces to remain exposed shall be cleaned and properly acid etched per floor sealer manufacturer's instructions. Fill and patch holes, crevices, cracks, etc.. Remove any paint, soil, loose material and dust. Remove oil or grease with a hot TSP solution and rinse thoroughly. Floor to be completely dry prior to etching with muriatic acid and water solution.

3.03 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
   1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
   2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
   3. Provide finish coats that are compatible with primers used.
   4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
   5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
   7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
   8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
   9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
   10. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
   1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
   2. Omit primer over metal surfaces that have been shop primed and touchup painted.
   3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
   4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
   1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
   2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
   3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:
   1. Uninsulated metal piping.
   2. Uninsulated plastic piping.
   3. Pipe hangers and supports.
   4. Tanks that do not have factory-applied final finishes.
   5. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
   6. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
   7. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   8. New rooftop gas piping.
   9. All existing and new exterior conduit, gas, water and similar piping at face of exterior walls.

G. Electrical items to be painted include, but are not limited to, the following:
   1. Switchgear.
   2. Panelboards.
   3. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
   1. Provide satin finish for final coats.

L. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.04 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
   1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.05 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
   1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces prior to final inspection. Comply with procedures specified in PDCA-P1.

3.06 EXTERIOR PAINT SCHEDULE

A. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.
   1. Full-Gloss Acrylic-Enamel Finish: Two finish coats over a rust-inhibitive primer.
      a. Primer: Exterior ferrous-metal primer.
      b. Finish Coats: Exterior full-gloss acrylic enamel for ferrous and other metals.

B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated metal surfaces:
   1. Full-Gloss Acrylic-Enamel Finish: Two finish coats over a galvanized metal primer.
      a. Primer: Exterior galvanized metal primer.
      b. Finish Coats: Exterior full-gloss acrylic enamel for ferrous and other metals.

C. Wood Doors: Provide the following paint finish systems over wood surfaces:
   1. Gloss Latex Finish: Two finish coats over a wood primer.
      a. Primer: latex wood primer.
      b. Finish Coats: gloss latex for wood surfaces.

D. Cement Fiber Board: Provide the following paint finish systems over cement fiber board surfaces:
   1. Latex Satin Finish: Two finish coats over primer.
      a. Primer: Loxon concrete primer.
      b. Finish Coats: latex satin finish.

3.07 INTERIOR PAINT SCHEDULE

A. New Concrete Unit Masonry: Provide the following finish systems over new interior concrete masonry:
   1. Semigloss Acrylic-Enamel Finish: Two finish coats over a block filler.
      a. Block Filler: Concrete unit masonry block filler.
      b. Finish Coats: Interior semigloss acrylic enamel.

B. Existing Concrete Unit Masonry or Brick: Provide the following finish systems over existing (previously painted) interior concrete masonry or brick:
   1. Egg shell Epoxy Finish: Two finish coats over primer / block filler.
      a. Primer / Block Filler: Acrylic-emulsion conditioner.
      b. Finish Coats: Pre-catalysed water-based epoxy.

C. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
   1. Semigloss Acrylic-Enamel Finish: (typical) Two finish coats over a primer.
      a. Primer: Interior gypsum board primer.
      b. Finish Coats: Interior semigloss acrylic enamel.
   2. Semi-Gloss Epoxy Finish: (at Apparatus Bay Ceiling, Kitchen Food Prep, Dry Storage, receiving, and serving areas, and at locker rooms, shower rooms, and restrooms): Two finish coats over primer.
      a. Primer: Interior gypsum board primer.

b. Finish Coats: Interior polyester epoxy.

D. Plaster: Provide the following finish systems over new interior plaster surfaces:
   1. Semigloss Acrylic-Enamel Finish: Two finish coats over a primer.
      a. Primer: Interior plaster primer.
      b. Finish Coats: Interior semigloss acrylic enamel.
   2. Full Gloss Epoxy Finish: (at Kitchen Food Prep, Dry Storage, receiving, and serving areas, and at locker rooms, shower rooms, and restrooms): Two finish coats over primer.
      a. Primer: Interior gypsum board primer.
      b. Finish Coats: Interior polyester epoxy.

E. Existing Plaster: Provide the following finish systems over existing (previously painted) interior plaster surface of exterior walls:
   1. Egg shell Epoxy Finish: Two finish coats over primer.
      a. Primer: High build latex wall primer.
      b. Finish Coats: Pre-catalysed water-based epoxy.

F. Wood and Hardboard: Provide the following paint finish systems over interior wood surfaces:
   1. Full-Gloss Alkyd-Enamel Finish: Two finish coats over a wood primer.
      a. Primer: Interior wood primer for full-gloss alkyd-enamel finishes.
      b. Finish Coats: Interior full-gloss alkyd enamel for wood and metal surfaces.

G. Ferrous Metal: Provide the following finish systems over ferrous metal:
   1. Full-Gloss Acrylic-Enamel Finish: Two finish coats over a primer.
      a. Primer: Interior ferrous-metal primer.
      b. Finish Coats: Interior full-gloss acrylic enamel.

H. Zinc-Coated Metal: Provide the following finish systems over interior zinc-coated metal surfaces:
   1. Full-Gloss Acrylic-Enamel Finish: Two finish coats over a primer.
      a. Primer: Interior zinc-coated metal primer.
      b. Finish Coats: Interior full-gloss acrylic enamel.

I. All-Service Jacket over Insulation: Provide the following finish system on cotton or canvas insulation covering:
   1. Flat Acrylic Finish: Two finish coats. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coats: Interior flat latex-emulsion size.

J. Interior Concrete Floors: Provide the following:
   1. 1st coat - Sealer / Reducer (400 SF/gal.)
   2. 2nd coat - Sealer / Reducer (600 SF/gal.)
      a. Exposed Concrete Finished Floors.

3.08 INTERIOR STAIN AND NATURAL-FINISH WOODWORK SCHEDULE

A. Natural-Finish Woodwork: Provide the following natural finishes over new interior woodwork not specified as shop finished:
   1. Alkyd-Based Satin-Varnish Finish: Two finish coats of alkyd-based clear satin varnish over a sanding sealer. Provide wood filler on open-grain wood before applying first varnish coat.
      a. Sealer Coat: Clear sanding sealer.
      b. Finish Coats: Interior alkyd- or polyurethane-based clear satin varnish.

END OF SECTION 09 91 00

SECTION 10 14 00 – SIGNAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Plaques.
   2. Dimensional illuminated characters.
   3. Panel signs.
   4. Adhered Vinyl Logos

B. Related Sections include the following:
   1. Division 01 Section "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
   2. Division 03 Section "Cast-in-Place Concrete."
   3. Division 09 Section "Gypsum Board."
   4. Division 26 Sections for electrical service and connections for illuminated signs.

1.03 DEFINITIONS

A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.04 SUBMITTALS

A. Comply with pertinent provisions of Division 01 Section "Submittal Procedures", unless otherwise indicated.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show fabrication and installation details for signs.
   1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.

2. Provide message list, typestyles, graphic elements including tactile characters and Braille, and layout for each sign.
3. Wiring Diagrams: Power, signal, and control wiring.

D. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
1. Plaque Casting: 6 inches square including border.
2. Dimensional Characters: Full-size Samples of each type of dimensional character (letter, number, and graphic element).
3. Aluminum: For each form, finish, and color, on 6-inch long sections of extrusions and squares of sheet at least 4 by 4 inches.
4. Acrylic Sheet: Full size for each color required.
5. Photoluminescent Signs: Full-size sign.

E. Sign Schedule: Location Key Plan for all signage. Use same designations indicated on Drawings.

F. Maintenance Data: For signs to include in maintenance manuals.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Materials properly protected and packaged so that no damage occurs during transit. Materials when delivered, protected by the Contractor against damage or theft.

1.06 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

C. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 COORDINATION

A. Coordinate placement of anchorage devices with templates for installing signs.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Deterioration of metal finishes beyond normal weathering.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.

B. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.

C. Bronze Castings: ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).

2.02 PLAQUES

A. Manufacturers: Subject to compliance with requirements, provide products by:
   1. Gemini Incorporated.

B. Cast Plaques: Provide castings free of pits, scale, sand holes, and other defects, as follows:
   1. Plaque Material: Cast metal with Bronze finish.
   2. Background Texture: Manufacturer's standard leatherette texture.
   3. Border Style: Square, polished.
   4. Mounting: Concealed studs for substrates encountered.

C. Plaque Schedule:
   1. Plaque Type as per drawings.

a. Plaque Size: As indicated in drawings.
b. Character Size: As indicated in drawings.
c. Character Finish/Color: Satin Finished Polished Metal.
d. Text/Message: Wording of plaque to be submitted and approved by architect prior to manufacturing of plaque.
e. Location: As indicated in drawings.
f. Quantity: One (1).

2.03 DIMENSIONAL CHARACTERS

A. Manufacturers: Subject to compliance with requirements, provide products by:
1. Gemini Incorporated.

B. Cast Characters: Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.
1. Character Material: Aluminum.
2. Thickness: 1 inch minimum.
3. Color(s): Duranodic Bronze.
4. Mounting: Concealed studs, non-corroding for substrates encountered, and projected 1" from wall.
5. Character Font: Tw Cent MT.

C. Aluminum Sheet: 3/8 inch thick.
1. Color: As selected by Architect from manufacturer's full range, including full range of RAL colors.
2. Mounting of Metal Lettering above Bay Doors: Refer to mounting detail in drawings, and provide 3 additional sets (in addition to 3 sets shown in drawings) of metal lettering with mounting bar/angles, so that the Fire Department may interchange wording above bay doors as required. Architect will provide wording for all 6 sets.
3. General Contractor to coordinate/provide galvanized steel angle securely mounted to building, to receive signage manufacturer's standard mounting bar/angle for each front bay door.
4. Character Font: Tw Cent MT.

D. Illuminated Letters and Numbers:
1. Character Material: Stainless Steel.
2. Return depth: 2"-3"
3. Finish:
a. Exterior Color: As selected by Architect from manufacturer's full range, including full range of RAL colors.
b. Interior Color: White.

4. Back: Clear Lexan.
5. Illumination: UL Listed LED Lighting,
   a. Color: White (3700-4000K), typical.
   b. Color: Red as indicated on drawings.
6. Mounting: Detachable studs with masonry anchors, 1.5" stand-off.

E. Street address: Where not indicated as "Back-Lit":
1. Material: Flat cut aluminum numbers.
2. Font: Tw Cent MT type, style as indicated on drawings, equal to Gemini architectural letters.
3. Numbers shall be primed and painted with two coats of enamel, color to be selected by Architect from standard colors.
4. Size: As Indicated on Drawings
   Numbers shall be mounted as per method #P-8 with masonry anchors and project 1-inch from wall.

2.04 WINDOW GRAPHIC

A. City Logo: At glazed front entrance door and sized as indicated in drawings, provide vinyl City of Georgetown logo, mounted to door glass with exterior grade adhesive. Architect will provide logo in non-vector electronic file format. Conversion to vector format graphics as required for fabrication provided by vinyl logo fabricator.

2.05 PANEL SIGNS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. 2/90 Sign Systems
2. Advacnce Corporation; Braille-Tac Division
3. Allen Industries Architectural Signage
4. Allenite Signs; Allen Marking Products, Inc.
5. APCO Graphics
6. ASI-Modulex, Inc.,
7. Best Sign Systems, Inc.
8. Bunting Graphic, Inc.
9. Fossil Industries, Inc.
10. Gemini Incorporated.
11. Grimco, Inc.
12. Innerface Sign Systems, Inc.
13. InPro Corporation
14. Matthews International Corporation; Bronze Division
15. Mills Manufacturing Company
16. Mohawk Sign Systems.
17. Nelson-Harkins Industries.
18. Seton Identification Products.

19. Signature Signs, Incorporated.
20. Supersine Company

B. Interior and Exterior Room Signage: Custom Arc "Modular", MOD008 as manufactured by 2/90 Sign Systems or approved equal. All signs must be ADA compliant. Refer to drawings for intended layout. Provide one sign for each room.
   1. Interchangeable component sign system:
      a. Size: As indicated on drawings, multiple line message, or larger size where required to accommodate sign messages.
      b. Structural rail
         1) 6063T5 extruded aluminum alloy, anodized black.
         2) Accepts extruded aluminum inserts on one or both ends.
         3) Accommodates different mounted devices.
         4) Top / Bottom trim extruded 6063T5 aluminum decorative trim cap, fit flush with adjacent copy insert, and enclosing bottom of rail and insert.
      c. Copy Inserts:
         1) Interchangeable, horizontal sliding inserts attached to structural rail with hook detail or magnets.
         2) Material for Inserts: PETG (faux aluminum finish) with raised numbers and braille for room numbers.
            a) Provide exterior grade signs where mounted outside of weather protective building enclosure. Locations: Apparatus Bays.
            b) Changeable Message Window Inserts with clear protective lens for paper inserts, provide at all rooms except restrooms, bathrooms, and stairwells.
         3) Graphics on paper inserts: Provided by Architect in non-vector electronic file format. Conversion to vector format graphics as required for fabrication provided by signage fabricator. Size and Type of Font to match raised numbers/letters on PETG inserts.
      d. End Cap / Structural Style: Interlocking end caps shall be extruded 6063T5 aluminum and shall interlock with structural rail with steel spring clips to form and integral unit, enclosing and securing the changeable copy inserts, without requiring special tools for assembly.
         1) Style: Equal to 2/90 Arc Modular, Thin.
         2) Profile: Equal to 2/90 Arc Modular Square Corner.
         3) Color: A**s** selected by Architect from Manufacturer's full range of finish options and paint colors.
         4) Provide tamper resistant feature.
      e. Mounting: Positive secure method (tamper-proof screws or toggle bolts). For installation on glazing, install with high strength mounting tape and provide blank signage of equal size to be mounted on opposite side of glazing.
   2. Typography:
      a. Type Style: TwCent MT**,** with letter width to height ratio between 3:5 and 1:1 and between 1:5 and 1:10. Copy shall be a true, clean, accurate reproduction of typeface(s) specified.
      b. Size of Letters and Numbers (Raised):
         1) 1" high room number
         2) 1" high room name

c. Letter Type: As indicated in Drawings.
   1) All Upper Case letters where required by ADA or TAS.
d. Letters and Numbers: Accompanied with Grade II Braille.
e. Braille: Braille shall be contracted (Grade 2) and compliant with all requirements of locally enforced handicap accessibility codes and standards.
f. Pictograms: Pictograms shall comply with recognized standards and locally enforced accessibility codes. Integrate verbal text descriptors and Braille below each raised pictogram, outside of the pictogram field.
   1) In addition to male/female pictograms, provide a "wheelchair" international handicap accessibility symbol on the signage for all accessible restrooms, bathing / shower rooms, and dressing / locker rooms.
g. Message Placement: As indicated in Drawings.
h. Margin Distance: Equal on all sides**.**
i. Interline Spacing for multiple lines of copy: As indicated in Drawings and 35% minimum to 70 percent maximum of the raised character height, and 3/8" minimum for spacing between text and Braille.
j. Letter Color: As selected by Architect from Manufacturer's full range of colors.

k. Background Colors: As selected by Architect from Manufacturer's full range of colors.

C. Exterior Parking Signage:
   1. Sign Type: 16" Gauge galvanized steel with 1" radius corners, shop painted and screw attached to 2” galvanized pipe post set in concrete footing. Allow for 1 sign including van accessible.

D. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color as selected by Architect from manufacturer’s standard colors.

E. Handicap Parking Signage: Refer to site plan and handicap signage detail on drawings.

2.06 WINDOW SIGNAGE

A. Vinyl

2.07 ACCESSORIES

A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.08 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.
   1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
   2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
   3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
   4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.09 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 ALUMINUM FINISHES

A. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify that items including anchor inserts and electrical power are sized and located to accommodate signs.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
   1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door. Coordinate exact location with Architect.

B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
   1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
   2. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
   3. Shim Plate Mounting: Provide 1/8-inch thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
   4. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.

C. Bracket-Mounted Signs: Provide manufacturer's standard brackets, fittings, and hardware for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.

D. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
   1. Projected Mounting: Mount characters at projection distance 1-inch from wall surface indicated.

E. Cast-Metal Plaques: Mount plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.
   1. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.

F. Exterior aluminum letters applied to clean, sound substrate. Letters installed securely, level, plumb, and true in spacing.

G. Interior signage applied to clean, sound substrate. This signage contractor responsible to properly clean substrates so that letters may be properly applied. Materials installed level, plumb, and true in spacing. Coordinate exact location with Architect.

H. Install building plaque 5’6” A.F.F.

3.03 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION 10 14 00

SECTION 10 22 13 - WIRE MESH PARTITIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Wire Mesh Partitions for walls.
   2. Sliding and swinging door panels.

B. Related Documents: The Contract Documents, as defined in Division 1 Section - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

1.03 SUBMITTALS

A. Division 1 Section - Submittal Procedures: Procedures for submittals.
   1. Product Data: Data for screen materials and finishes.
   2. Shop Drawings: Indicate plan and vertical dimensions, elevations, component details; head, jamb, and sill details; location of hardware. Provide component details, framed openings, bearing, anchorage, loading, welds, type and location of fasteners, and accessories or items required of related work.
   3. Assurance/Control Submittals:
      a. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
      b. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
   2. Installer: Company specializing in performing the Work of this Section with minimum 5 years documented experience.

1.05 DELIVERY, STORAGE AND HANDLING

A. Division 1 Section - Product Requirements: Transport, handle, store, and protect Products.

B. Deliver materials to job site in unopened containers bearing manufacturer's name and content identification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturer's offering Products which may be incorporated in the Work include the following:
   1. Acorn Wire and Iron Works, Chicago, IL (800) 552-2676.
   2. Indiana Wire Products, Incorporated, Greensburgh, IN (800) 451-0406.

3. Kentucky Metal Products Company, Louisville, KY (800) 331-3461.
4. Central Wire and Iron Works, Des Moines, IA (515) 244-2532.

B. Division 1 Section - Product Requirements: Product options and substitutions. Substitutions: Allowed, as approved by Architect.

2.02 WIRE MESH PARTITIONS

A. Partition Frame and Wire Mesh:
1. Wire: 10 gauge steel wire woven into 1-1/2" mesh, securely clinched to frames.
2. Vertical Frames: 1-1/4" x 5/8" cold rolled 'C' section channels with 1/4" bolt holes 12" o.c.; horizontal frames 1" x 1/2" cold rolled channels. All joints mortised and tenoned. Frame thickness.
3. Center Reinforcing Bar: 1" x 1/2" cold rolled channel tenoned to side frames. All wires shall pass through center bar.
4. Top Capping Bar: 2-1/4" x 1" cold rolled channel with 1/4" 'U' bolts 2'-4" o.c.
5. Corner Posts: 1-1/4" x 1-1/4" angles with 1/4" bolt holes to match partitions.
6. Floor Sockets (aluminum): 2-1/2" high with set screw adjustment.
7. Floor Angle: 1/1/4” x 1-1/4” angles.

B. Door and Frame:
1. Door Frames: 1-1/4" x 1/2" channel with 1-1/4" x 1/8" flat bar covering three sides, 1-3/8" x 3/4" x 1/8" angle riveted to lock side.
2. Doors:
   a. Hinged: 1-1/2 pairs butt hinges riveted to both door and transom bar.
   b. Sliding: Manufacturer's standard hardware assembly, including top support track and floor guide and complete roller assemblies.
3. Locks: Mortise type cylinder locks operated by key from outside, recessed knob inside, compatible with key system. Refer to Division 08 Section “Hardware” for additional requirements, if any.
4. Fasteners: Bolts, hardware, and accessories as required.
5. Finish: Minimum two shop coats of gray or black rust prohibitive enamel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Division 1 Section - Execution Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

C. Report in writing to Architect prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 INSTALLATION

A. Install Work under this Section in accordance with manufacturer's printed recommendations.

B. Determine location of partition. Secure floor sockets to floor with suitable fasteners. Shim as required for vertical installation. Shims for horizontal alignment will not be allowed.

C. Erect partitions in a secure manner, level and plumb. Install floor angles to tolerance to prevent an individual from sliding a registered letter along the floor to outside the cage.

D. Insure that door(s) operate without binding including all latching hardware.

E. Install all accessories required for a complete installation.

3.03 CLEANING

A. Clean all surfaces and leave installation ready for field painting.

END OF SECTION 10 22 13

SECTION 10 26 00 - WALL AND CORNER PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Corner guards.

B. Related Sections:
   1. Division 07 Section "Joint Sealants."
   2. Division 08 Section "Hardware."
   3. Division 09 Section "Painting."
   4. Division 09 Section "Gypsum Board."

1.03 SUBMITTALS

A. Product Data: Product data and detailed specifications for each system component and installation accessory required, including installation methods for each type of substrate.

B. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below. Include Samples of accent strips and trims to verify color selected.
   1. Corner Guards: 12 inches long. Include examples of joinery, corners, end caps, top caps, and field splices.
   2. Wall Protection: 12 inch by 12 inch sample. Include aluminum trims.

D. Material Certificates: For each impact-resistant material, from manufacturer.

E. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.
   1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
   1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
   2. Keep plastic sheet material out of direct sunlight.
   3. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
      a. Store corner-guard covers in a vertical position.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Deterioration of plastic and other materials beyond normal use.
   2. Warranty Period: Five years from date of Substantial Completion.

1.08 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Acceptable Manufacture: CS Acrovyn® Corner and Wall Protection Systems, Construction Specialties:
   1. Kipco & CS Gulf Coast, 7155 Old Katy Road Suite S104, Houston, Texas 77024 713-590-0660 info@csgulfcoast.com

B. Provide all corner guards and wall protection from a single source.

2.02 MANUFACTURED UNITS

A. Flush Mount Corner Guard: Engineered PETG Corner Guards to be CS Acrovyn: Flush mounted guards consisting of aluminum retainer with snap-on Acrovyn 4000 cover. Retainer to be taped and spackled into adjacent drywall. Extruded aluminum base and closure gasket at all locations U.N.O. Attachment hardware shall be appropriate for wall construction.
   1. Flush Mount Corner Guard
      a. Model, Size: SFS-20N 90° flush mounted corner guard with 2" (51.1mm) legs and 1/4" (6.4mm) radiused cover and aluminum retainer. For integral fire barrier, provide SFS-20RN 1HR for one-hour fire rated installation and SFS-20RN 2HR for two-hour fire rated installation at Fire Rated assemblies as indicated in drawings.
      b. Height – 8’ A.F.F.

2.03 MATERIALS

A. Corner Guards:
   1. Engineered PETG: Extruded material should be high-impact Acrovyn 4000 with Shadowgrain texture, nominal .078" (1.98mm) thickness. Chemical and stain resistance should be per ASTM D543 standards as established by the manufacturer. Colors to be indicated in the finish schedule from one of manufacturer’s available colors and patterns.
   2. Aluminum: Extruded aluminum retainers should be 6063-T6 alloy, nominal .070" (1.78mm) thickness. Minimum strength and durability properties as specified in ASTM B221.
   3. Fasteners: All fasteners to be non-corrosive and compatible with aluminum retainers. All necessary fasteners to be supplied by the manufacturer.

B. Finishes
   1. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applications and designations of finishes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances**,** and other conditions affecting performance of work.
   1. Complete all finishing operations, including painting, before beginning installation of corner guards.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Before installation, clean substrate to remove dust, debris, and loose particles.

3.03 INSTALLATION

A. General: Install impact-resistant wall protection units true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work. Locate the corner guard as indicated on the approved detail drawing for the appropriate substrate and in compliance with the manufacturer installation instructions. Install corner guard level and plumb at the height indicated on the drawings.

B. Installation of Corner Guard:
   1. Install the work of this section in strict accordance with the manufacturer's recommendations, using only approved mounting hardware, and locating all components firmly into position, level and plumb.
   2. Temperature at the time of installation must be between 65°-75°F (18°-24°C) and be maintained for at least 48 hours after the installation.
   3. Offset base of corner guard from finish floor height of resilient base as scheduled in drawings, to allow continuous wrapping of base around corners. Coordinate this condition with drywall installer. Top of corner guard should remain 8' A.F.F., refer to finish detail in drawings.

3.04 CLEANING

A. Immediately after completion of installation, clean guards, and accessories with manufacturer's recommended cleaning method.

B. Remove excess materials using methods and materials recommended in writing by manufacturer.

3.05 PROTECTION

A. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

END OF SECTION 10 26 00

SECTION 10 28 13 - TOILET ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide accessories as shown on the drawings and as herein specified.

B. Related Sections include the following:
   1. Division 6 Section: Blocking in Stud Walls for Accessories

1.03 QUALITY ASSURANCE

A. Model numbers listed for toilet accessories are items manufactured by Bobrick Corporation. Items as made by the Bradley Corp., American Specialties Co. Charles Parker Co. may be used provided materials meet performance and design requirements herein specified.

B. All bathroom fixtures and accessories shall comply with all ADA federal, state and local Handicapped code requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver items in manufacturer's unopened protective cartons. Maintain covers on units until installation is complete. Remove protective covers at final clean-up of installation.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each toilet accessory.

PART 2 - PRODUCTS

2.01 ITEMS

A. Soap Dispensers:
   1. At Treatment Room and Restroom/Bathroom Sinks: Wall surface-mounted soap dispenser with spout and 1200ml foaming soap container. Equal to Georgia Pacific 53053.

B. Paper Towel Dispensers:
   1. Surface-mounted Roll Dispenser (at all restrooms/bathrooms and treatment room): Durable plastic roll type dispenser, pull-type mechanism compliant with ADA and local handicap accessiblity codes requirements, accommodating 8" wide x 8" diameter paper towel rolls, with locking cabinet. Equal to Georgia Pacific 59589.

C. Toilet Tissue Dispenser:
   1. Surface-mounted: Cabinet type compact vertical stacked double roll holder, equal to Georgia Pacific 56790.

D. Waste Receptacles: Owner provided.

E. Undersink Pipe Insulation: ADA compliant vinyl cover pipe insulation shall be TRUEBRO "Lav Guard 2", as manufactured by ISP Corp., in standard color, or approved equal.

F. Grab Bars: 1-1/2" diameter satin finish stainless steel grab bar sets with concealed fastenings. Bobrick Series B-6806. Lengths and mounting configurations shall comply with all state and local Handicapped Accessibility code requirements.

G. Towel Bars: 3/4" square, 24" long, stainless steel towel bar with concealed fastenings. Equal to Bobrick Series B-6747.

H. Mop Racks:
   1. Mop and Broom Holder with Hooks and Shelf: Stainless steel with three mop and broom holder clips, four double stainless steel hooks, and 8" deep shelf above, 34" long. Equal to Bobrick B-239.

I. Mirrors:
   1. Framed Wall Mirrors: No. 1 quality 1/4" float plate glass selected for silvering, electro-copper plated by galvanic process, surface-mounted mirror with stainless steel channel and filler strip on 1/8" non-abrasive polyethylene padding equal to:
      a. Bobrick No. B-165-2448 (public restroom) and
      b. Bobrick No. B-165-4836 (bathrooms). Mount vertically.
   2. Unframed Plate Glass Mirrors: Refer to Division 08, Section "Glazing".

J. Coat and Towel Hooks:
   1. Single Robe Hook: Hook and flange one-piece solid brass with satin nickel-plated finish, surface-mounted with concealed fasteners, equal to Bobrick #B2116. (3 per bathroom).

K. Folding Shower Seats: Folding shower seat of water resistant, ivory color 1/2" thick phenolic. Frame and mounting brackets of stainless steel and feature self locking mechanism. Seat shall be Bobrick No. B-5181 or approved equal.

L. Shower Curtains and Rods: White opaque 0.2 mm thick vinyl curtain equal to Bobrick B-204-2 (42" W), with stainless steel hooks B-204-1 on 1" dia. stainless steel rod and mounting brackets B-6107 Series curtain rod.

M. Baby Changing Stations:
   1. Stainless Steel fold down FDA approved, equal to Koala Bear Changing Station KB110-SSWM.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All handicapped bathroom fixtures and toilet accessories shall comply with all federal, state and local Handicapped code requirements and comply with TAS (Texas Accessibility Standards) mounting locations and heights.

3.02 INSPECTION

A. Inspect blocking and plate inserts in framing to determine if material is in proper position for installation of accessories prior to wallboard surfacing being applied. Units securely attached to framing. Grab bars installed to withstand a 900 lb. loading condition; provide necessary concealed anchorage devices to meet load requirements.

END OF SECTION 10 28 13

SECTION 10 41 00 – KNOX BOX

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 DESCRIPTION

A. Provide and install knox box as shown on the drawings and as herein specified.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Division 08 Section "Hardware"

1.04 PRODUCT DELIVERY AND STORAGE

A. Deliver all products to job site in manufacturer's original, standard containers with seals unbroken and labels intact.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and color chips for all products specified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Knox Company, 1601 West Deer Valley Road, Phoenix, AZ. 85027, www.knoxbox.com.
   1. Knox Box Series 3200 Hinged Door Recessed Model
      a. Recesssed mount with flange.

B. Provide knox box equal to Knox Box Recessed Mount System
   1. Hinged door.
   2. Color to be selected by Architect.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine all surfaces receiving knox box for any defects that would impair installation and if any are found, make such corrections.

3.02 INSTALLATION

A. Install units using manufacturer's standard recommended methods. Use manufacturer's standard hardware where recommended to secure units into the wall.

3.03 PROTECTION AND CLEANING

A. Clean exposed surfaces.

B. Protection: Installer shall advise contractor of final protection and maintenance conditions necessary to ensure that work will be without damage at time of acceptance.

END OF SECTION 10 41 00

SECTION 10 44 12 - FIRE EXTINGUISHERS AND FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Portable fire extinguishers.
   2. Mounting brackets.
   3. Fire extinguisher cabinets.

B. Related Sections:
   1. Division 06 Section "Rough Carpentry."
   2. Division 06 Section "Wood Framing."
   3. Division 09 Section "Gypsum Board."

1.03 SUBMITTALS

A. Comply with pertinent provisions of Division 01 Section "Submittal Procedures", unless otherwise indicated.

B. Product Data:
   1. For Fire Extinguishers. For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
   2. Fire Extinguisher Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.

C. Shop Drawings: For Fire Extinguisher Cabinets: Include plans, elevations, sections, details, and attachments to other work.

D. Product Schedule:
   1. For Fire Extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.
   2. For Fire Extinguisher Cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

E. Operation and Maintenance Data:
   1. For fire extinguishers to include in maintenance manuals.
   2. For fire extinguisher cabinets to include in maintenance manuals.

F. Warranty: Sample of special warranty.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain products in this section from one manufacturer.

B. For fire extinguishers. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
   1. Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   2. Provide fire extinguishers approved, listed, and labeled by FMG.
   3. UL-Listed Products: Provide new portable fire extinguishers which are UL-listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.

C. Fire-Rated, Fire Extinguisher Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

1.05 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire extinguisher cabinets with wall depths.

1.06 WARRANTY

A. Special Warranty for Fire Extinguishers: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by:
      a. J. L. Industries, Inc.; a division of Activar Construction Products Group. "Cosmic" Series Model 5E with nozzle.
   2. Valves: Manufacturer's standard.
   3. Handles and Levers: Manufacturer's standard.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix Band bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type: UL-rated 5 lb. nominal capacity, with monoammonium phosphate powder in manufacturer's standard heavy duty steel cylinder with powder coat finish. Model: Galaxy 10.

C. Wet Chemical: J.L. Industries, Inc. Saturn Series for class 'K' series. Model: Saturn 15.

2.02 MOUNTING BRACKETS

A. Brackets: Equal to J. L. Industries Mark Brackets, Model No. MB 818 complete with required anchors, of required size for Cosmic 5X fire extinguishers.

B. Mounting Brackets: Manufacturer's Standard galvanized steel, designed to secure fire extinguisher to wall or structure. Brackets are to be used in Apparatus Bay only.

C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

2.03 FIRE EXTINGUISHER CABINET

A. Cabinet Type: Suitable for fire extinguisher.
   1. Products: Subject to compliance with requirements, provide the following:
      a. JL Industries, Inc.; 8115, 8117

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Steel sheet.

D. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

E. Clear Acrylic: ASTM C 1036, Type I, Class 1, Quality q3.

F. Semi-recessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door

frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semi-recessed cabinet installation.

1. Rolled-Edge Trim: 2-1/2-inch backbend depth.

G. Cabinet Trim Material: Same material and finish as door.
   1) Door Material: Steel sheet.

H. Door Style: Fully glazed panel with frame.

I. Door Glazing: Acrylic.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

K. Accessories:
1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Door Lock: None.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
   a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER".
      1) Location: Applied to cabinet glazing.
      2) Application Process: Silk-screened.
      3) Lettering Color: White.
      4) Orientation: Vertical.

L. Finishes:
1. Manufacturer's standard baked-enamel paint for the following:
   a. Exterior of cabinet, door, and trim except for those surfaces indicated to receive another finish.
   b. Interior of cabinet and door.
2. Baked enamel or powder coat.

2.04 FABRICATION OF FIRE PROTECTION CABINETS

A. Fire Extinguisher Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.05 GENERAL FINISH REQUIREMENTS OF FIRE PROTECTION CABINETS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 STEEL FINISHES OF FIRE PROTECTION CABINETS

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning". Retain paragraph below for factory-applied, baked-enamel or powder-coat finish for steel sheet.

B. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Fire Extinguishers:
1. Examine fire extinguishers for proper charging and tagging.
2. Remove and replace damaged, defective, or undercharged fire extinguishers.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Fire Extinguisher Cabinets:

1. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.
3. Prepare recesses for semi-recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.02 INSTALLATION

A. Fire Extinguishers:
   1. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   2. Mounting Brackets: Maximum 54 inches above finished floor to top of fire extinguisher, to comply with applicable regulations of governing authorities as directed by local Fire Marshall.
   3. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

B. Fire Protection Cabinets:
   1. General: Install fire protection cabinets in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities as directed by local Fire Marshall.
   2. Fasten cabinets to structure, square and plumb.
   3. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi-recessed fire protection cabinets.
   4. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

C. Coordinate all fire extinguisher types and mounting locations with Fire Marshall.

3.03 ADJUSTING AND CLEANING OF FIRE PROTECTION CABINETS

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

C. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.

D. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 12

SECTION 10 51 40 – BUNKER GEAR STORAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Standard Form of Construction Agreement, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 DESCRIPTION

A. Provide and install gear storage units as shown on the drawings and as herein specified.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Division 04 Section "Concrete Masonry Units"

1.04 PRODUCT DELIVERY AND STORAGE

A. Deliver all products to job site in manufacturer's original, standard containers with seals unbroken and labels intact.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product literature for all products specified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide GearGrid storage units manufactured by Mid-Minnesota Wire, 670 SW 15th Street, Forest Lake, MN, 55025, 888-643-6694. Fax 651-464-4780 website: www.geargrid.com

2.02 MATERIALS

A. Provide storage units as indicated in drawings, equal to GearGrid wall mount PPE Storage Personnel Lockers single sided system, including all necessary brackets and fasteners for complete installation. Include the following options/accessories:
   1. 2 adjustable shelves (HDPE) per unit.
   2. 3 adjustable apparel hooks per unit.
   3. 1 nameplate holder per unit.
   4. 24" wide x 30.5" deep x 70" tall (verify required blocking location in walls with manufacturer).
   5. Integrated Lifting Seat: Heavy -duty welded steel tube with solid panel (HDPE).
   6. Accessories (1 per unit):
      a. Gearglove drying hanger
      b. Geardryer coat drying hanger
      c. Helmet Holder

2.03 FINISH

A. Durable powder coat finish, color: Red.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine all surfaces receiving gear storage units for any defects that would impair installation and if any are found, make such corrections.

3.02 INSTALLATION

A. In stud wall mounting applications, General Contractor shall provided necessary blocking in walls at required heights per manufacturer's recommendation prior to covering with drywall, to insure secure wall mounting of gear lockers.

B. Install units using manufacturer's standard recommended methods. Use manufacturer's standard hardware where recommended to secure units to the wall.

3.03 PROTECTION AND CLEANING

A. Clean exposed surfaces.

B. Protection: Installer shall advise contractor of final protection and maintenance conditions necessary to ensure that work will be without damage at time of acceptance.

END OF SECTION 10 51 40

SECTION 10 73 16 - PREFABRICATED ALUMINUM CANOPIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, shall apply to work specified in this Section.

1.02 SUMMARY

A. Work in this section shall include design, fabrication and installation of complete, mechanically fastened, extruded aluminum protective cover system including foundations. All work shall be in complete accordance with the drawings and this specification.

B. Related Sections:
   1. Division 03 Section: "Concrete", concrete for canopy column footings.
   2. Division 04 Section “Unit Masonry” for coordination of support engineering with masonry walls supporting canopy system.
   3. Division 05 Section: "Structural Steel", for steel brackets and supports at and inside building walls.
   4. Division 05 Section: "Cold-Formed Metal Framing", for cold formed support framing for canopy attachments.
   5. Division 07 Section: "Metal Wall and Soffit Panels", and Division 09 Section "Metal Support Systems", for coordination with metal soffit panels installed to and supported by canopy system.
   6. Division 07 Section: "Sheet Metal Flashing and Trim".
   7. Division 07 Section: "Joint Sealants".
   8. Division 26 Section: "Electrical", for coordination of routing of conduit and installation of electrical devices at canopies.
   9. Division 32 for coordination with paving installed under and around canopies.

1.03 REFERENCES

A. The Aluminum Associate - Aluminum Design Manual 2010.

B. American Welding Society - AWS D1.2/D1.2M: 2008.

1.04 SUBMITTALS

A. Furnish complete shop drawings bearing the seal of a registered engineer showing the required live and wind loads of the project. Shop Drawings shall clearly illustrate all details, including, but not limited to: Plan views, drainage locations and details, building wall condition details, flashing details, canopy component sizing and thickness, fastener sizing, large scale assembly details, and finishes by component. General Contractor to verify all dimensions and elevations prior to submittal to Architect. Submittal shall be checked by manufacturer prior to fabrication. The site specific shop drawings and calculations shall bear the seal of a Structural Engineer licensed to work in the state of the project site.

B. Submit samples for finish and color selections. Provide two samples of specified finish: minimum size: 2-1/2” x 4”.

C. Submit manufacturer’s brochure and product data.

1.05 QUALITY ASSURANCE

A. Canopy Manufacturer shall have a minimum 10 years experience in designing and installing aluminum canopy systems.

B. Installation shall be performed by aluminum canopy manufacturer to ensure a single source responsibility for the work.

1.06 ENGINEERING REQUIREMENTS

A. Canopy shall be designed to comply with local building codes and the following, whichever is most stringent:
   1. Canopies shall be capable of withstanding a 20-pound live load, & 110-mph wind loads, or as required by state and local building codes having jurisdiction. Structure shall be capable of sustaining hail, and support being walked on by maintenance personnel.
   2. Canopies and canopy components shall be designed to withstand loads imposed by metal soffit framing and panels, and sign letters, installed to and supported by components of the canopy system, including associated wind loads to 110-mph.
   3. Canopy fascias designed of adequate thickness to prevent oil canning.

1.07 WARRANTY

A. Provide manufacturer's 1-year Warranty against defects in material and workmanship, and 1-year Warranty on field installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Basis of Design Manufacturer: Design is based on the prodcuts of MASA Architectural Canopies. Subject to compliance with requirements, Pre-Frabricated Aluminum Canopies by one of the following, or other approved equal:

INMASA Architectural Canopies, 21 Randolph Ave., Avenel, NJ 07001, 800-761-7446.

   2. Other manufacturers must have a minimum of 10 years experience manufacturing extruded walkway canopies, have products that meet or exceed the specifications, and that serve the same function, performance, sizing, and appearance. Submit for approval in conformance with Division 1 sections regarding "Substitutions".

2.02 MATERIALS

A. All components shall be 6061, 6063, or 6065 Alloy extruded aluminum. All components shall be sized as required to meet engineering requirements of the project, sizes and depth indicated in Drawings, and as follows, whichever is greatest except that canopy member depths shall not exceed depths shown in Drawings unless specifically approved by Architect:
   1. Outrigger Supports: ¼" flat aluminum plate.
   2. Framing: Extruded aluminum Rectangular Tube 2" x 8" x 1/8" thick.
   3. Wall mounted canopy Truss Rods: Equally sized throughout, minimum size as determined by Manufacturer for loading conditions.
   4. Deck: As indicated in drawings over front entry
      a. Standard decking, of required thickness as determined by manufacturer.
   5. Infill louvers: As indicated in drawings on each side of solid deck over front entry
      a. Type: Hollow extruded aluminum airfoil (Solid plate blade)
      b. Size: 6" x 1-1/2"

B. Drainage

1. Drainage trim rings through bottom of canopy: Where indicated in Drawings, water shall drain through equal sized round trim rings extending down through canopy soffit or fascia / beams, located at the corners of canopies as indicated in Drawings.
    a. Water to free-fall to paved surface or rock mulch surface as detailed in Drawings.

C. Fasteners, Connections and Fittings: All components provided by canopy Manufacturer.
1. All bolts, nuts, washers, and screws used in joining the members shall be stainless steel.
2. Where exposed fasteners are not avoidable, visible fasteners or components must be finished to match surrounding surfaces.
3. Component Accessories: Shall be of similar materials as specified for prime components.
4. Flashing: Minimum .040, color to match canopy system decking.

D. Finish: Finish and color selection of each component shall be Manufacturer's standard coating process, selected from the Manufacturer's standard color selections.
1. AAMA 2605, fluoropolymer coating containing minimum 70 PVDF resins.

2.03 FABRICATION

A. Columns and beams shall be heliarc welded.

B. Decking:
1. Decking shall be an extruded aluminum component with an interlocking and self-flashing design to provide structural integrity for the completed assembly.
2. Decking shall be mechanically fastened in the field.
3. The canopy deck is to have welded end closures at the deck terminations.
4. Fabricate decking sections at light fixtures with cap detail as shown in Drawings that will conceal conduits and shield electrical devices from rain water.

C. Concealed Drainage:
1. Water shall drain from covered surfaces into an integral gutter system and directed through scuppers at designated locations at canopies.
2. Water shall drain from covered surfaces into an integral gutter system and directed through scuppers to drain through the columns.

D. Flashing shall be prefinished .040 aluminum fabricated to prevent leakage between canopy and adjacent structures.

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate installation requirements with the work of other trades, including but not necessarily limited to the following:
1. Structural elements supporting or partially supporting prefabricated metal canopies. Coordinate exact size and locations of mounting plates and attachments provided by other trades as required, prior to preparation of shop drawings for such supports and for the canopy system.
2. Drainage requirements, including connections to below grade piping.
3. Grades and levels of concrete and other adjacent paving.
4. Coordination with routing of electrical work, including supports and attachment details, to ensure waterproof installation, with conduit hidden from view to the maximum extent possible. Install conduit as work progresses. See Electrical Routing article below and details in Drawings.
5. Coordination with work of other trades where adjacent or attaching to canopy.
6. Wash down of masonry, and other work in the vicinity that could damage canopy finishes after installation, should be complete prior to canopy installation.

B. Examine conditions and preparations for installation made by other trades, prior to installation. Inform general contractor of any deficiencies. Do not proceed to installation until deficiencies are corrected; beginning installation constitutes acceptance of substrates / conditions.

3.02 INSTALLATION

A. Install canopy in accordance with manufacturer's recommendations and instructions.

B. Erect canopy after adjacent concrete and masonry work is complete and washed down.

C. Install columns and beams straight and true.

D. Install raincaps over draining sections of deck.

E. Install flashing as required.

F. Prevent damage or scratching during installation.

G. Fill downspout columns with grout to the discharge level to prevent standing water, and sloped to drain out discharge hole. Deflectors shall be installed after grouting.
   1. Provide concrete splash blocks at downspouts and downspout columns that do not discharge to paving or other hard or rock mulch type surface.

3.03 ELECTRICAL ROUTING

A. General: Electrical conduits and penetrations through roof deck shall be concealed in finished canopy construction and detailed for weathertight construction as indicated in Drawings and herein specified.

B. Strip protective coatings or coverings from aluminum at time as indicated by Manufacturer; do not allow to melt to metal surfaces. Clean all parts prior to substantial completion. Repair to new condition to replace any materials damaged during installation.

C. Take precautions to prevent damage to canopy and finishes during and after installation.

D. Thoroughly clean canopy after installation.

END OF SECTION 10 73 16

SECTION 10 75 00 - FLAGPOLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide and erect flagpoles including all standard fittings as specified herein. Actual location of flagpoles as shown on Drawings or directed by Architect.

B. Related Sections include the following:
   1. Division 3 Section: Concrete.
   2. Division 26, Electrical, for grounding requirements.

1.03 SUBMITTALS

A. Submit manufacturer's technical data and installation instructions for each type of flagpole required.

B. Submit shop drawings of flagpoles and bases, showing general layout, jointing and complete anchoring and supporting systems.

1.04 QUALITY ASSURANCE

A. Manufacturing Standards: Provide each flagpole as a complete unit produced by a single manufacturer, including fittings accessories, bases and anchorage devices.

B. Design Criteria: Provide flagpoles and installations constructed to withstand a 120 mph wind velocity minimum when flying flag of appropriate size. Poles up to 35’ exposed height come in single piece construction. Taller is 2 or more pieces.

C. Pole Construction: Construct pole and ship to site in one piece if possible. If more than one piece is necessary, provide snug-fitting, precision joints with self-aligning, internal splicing sleeve arrangement for weather-tight, hairline field joints.

1.05 DELIVERY, STORAGE AND HANDLING

A. Spiral wrap flagpoles with heavy Kraft paper or other protective wrapping and prepare for shipment in hard fiber tube or other protective container.

B. Deliver flagpoles and accessories completely identified for installation procedure. Handle and store flagpoles to prevent damage or soiling.

PART 2 - PRODUCTS

2.01 GROUND SET FLAGPOLES

A. Manufacturers: Flagpole specifications are based upon flag poles and manufactured by Concord Industries, Inc., 4150A Kellway Circle, Addision TX 75001, 800-527-3902, www.concordindustries.com. Subject to compliance with requirements, provide the named products or comparable products by another manufacturer.
   1. Substitutions: as approved by Architect

B. Equal to the following specifications for Concord Industries “Estate” series, with the following standards and options:
   1. Flag Poles: Commercial ground set, one piece, cone tapered aluminum (6063-T6) flagpole.
      a. Number of poles: 2.
      b. Exposed height: 25'-0"
      a. Outside Butt Diameter: 5”
      b. Wall Thickness: .188”
      c. Finish: Clear Anodized (Class I, > 0.7 mil).
   2. Base, spun aluminum flash collar.
      a. Equal to Concord #FC11.
   3. Flag Arrangement:
      a. Flags: Provide the following flags, with rip stop nylon furnished with two non-corrosive grommets:
         1) American flag with embroidered stars and sewn stripes: 4’x6’.
         2) Texas State Flag: 4’x6’.
   4. Halyards and Truck Assembly: External halyards, #10 white water-proof polypropylene, equipped with 2 chrome swivel snaps.
      a. Cleats –9" aluminum. Tamperproof stainless head bolts.
      b. Truck - Cast aluminum with stainless steel ball bearings.
      c. Cleat Cover and Halyard Boxes: Key operated cylinder lock box of finish to match pole.
   5. Foundation sleeve - #16 gauge galvanized steel, with steel base plate and as detailed on the drawings.
   6. Finial: #14 gauge aluminum ball with a flush seam and gold anodized finish.
      a. Manufacturer's standard flush seam ball in size to match pole butt diameter.

2.02 WALL MOUNTED FLAGPOLES

A. Basis of Design: Design is based upon Outrigger Single Stationary flag poles as manufactured by American Flagpole. Subject to compliance with specifications, provide the named product, or approved equal.
   1. American Flagpole
      26252 Hillman Highway
      Abingdon, VA 24210
      1-800-368-7171
      http://www.americanflagpole.com
   2. Subtitutions: as approved by Architect

B. Aluminum Flagpole Construction: Fabricate from seamless, extruded tubing complying with ASTM B 221, alloy 6063-T6, having a tensile strength not less than 30,000 psi with a yield point of 25,000 psi.Heat treat after fabrication to comply with ASTM B 597, temper T6.
   1. Provide cone-tapered flagpoles, per manufacturer’s standard rate of taper.
   2. Assembly Construction: Vertical Single Stationary - Rope Halyard – Wall Mount.
   3. Flagpole Model No. : VTS1-12B31-ACL.

C. Mounting: Fabricated aluminum wall mount brackets for thru wall or anchor bolt mounting. Stainless steel socket type cup point set screws will be provided for pole installation in sleeve. Anchorage for brackets to be supplied by installer
   1. Mounting Bracket Model No.: VW-0003-ACL

D. Flag Arrangement: Owner Provided

E. Fittings:
   1. Finial: #14 gauge aluminum ball with a flush seam and gold anodized finish.
      a. Manufacturer's standard flush seam ball in size to match pole butt diameter.
   2. Single Stationary Truck Assembly: Cast aluminum non-fouling with single pulley and pin, provided with three set screws for attachment to pole.
   3. Halyard: Provide one (1) continuous 5/16" (#10) polyester halyard.
   4. Halyard Flag Snaps: Provide two (2) solid brass swivel flagsnaps with neoprenecovers.
   5. Cleat(s): Provide one (1) heavy-duty cast aluminum cleat (9") with stainless steel attaching screws.
   6. Flash Collar: Provide Spun Aluminum Collar to match flagpole. See Specification Drawing for Collar Specification.

F. Finishes:
   1. Metal Finishes, General: Comply with National Association of Architectural Manufacturers' (NAAMM) "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2. Finish Specification: Aluminum Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
      a. Anodized Finishes: Provide Class 1 finish complying with AA M32-C22-A41 (Clear Anodized) or AA M32-C22-A42 (ColorAnodized Finishes) in thicknesses ranging from 1 to 3 mils.
         i) Anodized finish: Clear (ACL)

PART 3 - EXECUTION

3.01 COORDINATION

A. Coordinate installation of lighting and electrical work with other trade as required.

B. Coordinate installation of concrete flatwork around flagpole base, so that adjacent concrete is flush with base.

3.02 INSTALLATION

A. Prior to installation, verify that pole equipment may all be installed in accordance with the manufacturer's recommendation; notify the Architect of any areas of discrepancy before proceeding with the installation.

B. Install concrete foundations in accordance with manufacturers standards.

C. Install poles according to Manufacturer's instructions.

END OF SECTION 10 75 00

SECTION 11 31 00 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Cooking equipment including:
      a. Gas Range
      b. Range Hood with Fire Suppression
      c. Microwave
      d. Coffee Maker
   2. Refridgerator/Freezers
   3. Icemakers
   4. Cleaning appliances:
      a. Dishwasher
      b. Clothes washer
      c. Clothes dryer
      d. Extractor
      e. Gear Dryer
   5. Compressed Air Equipment
      a. Air Compressor
      b. SCBA Compressor
   6. Coordinate appliance dimensions and operating clearances with millwork.

B. Related Sections include the following:
   1. Division 1 Section “Construction Waste Management”
   2. Division 6 Section “Millwork”
   3. Division 22 Section “Compressed Air Piping and Valves”
   4. Division 22 Section “Gas Connection”
   5. Division 23 Section “Venting”
   6. Division 26 Section “Electrical Connection”

1.03 QUALITY ASSURANCE

A. Provide residential equipment which complies with standards and bears certification labels as follows:
   1. Provide residential equipment with U. L. labels.

B. Available Manufacturers: Listed in Part 2 below, or as approved by Architect.

1.04 PRODUCT STORAGE, DELIVERY AND HANDLING

A. Deliver products to project site in manufacturer's undamaged protective containers after spaces to receive them have been fully closed.

1.05 SUBMITTALS

A. Submit manufacturer's specifications and installation instructions for each type of appliance, including data indicating compliance with requirements. Submit operating and maintenance instructions for each item of residential equipment.

B. Submit schedule of appliance, using same unit and building designations shown on drawings.

C. Shop Drawings: For range exhaust hood. Include plans, elevations, sections, roughing-in dimensions, fabrication details, utility service requirements, and attachments to other work.

1.06 WARRANTY

A. Submit manufacturer's standard written warranty for each item of residential equipment.

1.07 COORDINATION

A. Coordinate with other trades by providing requirements for proper installation.

PART 2 - PRODUCTS

2.01 APPLIANCES

A. Gas Ranges: 36” NG (Natural Gas) range with griddle– Wolf Model No. GR364G.

B. Range Hood: Ventilating type with factory installed Fire Suppression System. 36" Hood for mounting below wall cabinets with variable fan speed, Grease baffle, charcoal filter, built-in lighting, Stainless Steel finish, rated at 380 cfm, minimum, 470 cfm maximum. Hood shall be as manufactured by Denlar Fire Protect, Model No. D1036-I_DF. Refer to Mechanical drawings and specifications for additional requirements.

C. Refrigerators: Owner Provided, Contractor Install. KitchenAid Model No. KRBR102ESS.

D. Dishwasher: Stainless Interior Built-In Dishwasher with Hidden Controls and Stainless Steel Door, Energy Star Qualified KitchenAid Model No. KDTM354ESS.

E. Garbage Disposals: 3/4 Horsepower Continuous Feed Disposer, KitchenAid “Superba” Model No. KCDS075T.

F. Under Counter Water and Ice Cube Dispenser: Gravity Drain, Follett Model No. 7UC100A.

G. Free-Standing Ice Maker: Owner Provided, Contractor Install. Mantiowoc Model No. QD-0132A

H. Microwave Ovens: Owner Provided, Contractor Install. 1.6 Cu. Ft. Countertop Microwave Oven, KitchenAid Model No. KDTM354ESS with Stainless Steel “built-in” trim kit (1 per microwave).

I. Coffee Maker: Owner Provided and Installed: BUNNCWTF15 3LPF.

J. Outdoor Gas Grill: Owner Provided and Installed.

2.02 CLEANING EQUIPMENT

A. Washer: Owner Provided, Contractor Install. Speed Queen FR7004WN

B. Dryer: Owner Provided, Contractor Install. Speed Queen DR7000WE

C. Extractor: Owner Provided, Contractor Install. UniMac UWN035K12OU3001

D. Gear Dryer: Owner Provided, Contractor Install. UniMac UTGC6EDG4401W01

2.03 COMPRESSED AIR EQUIPMENT

A. Air Compressor: Owner Provided, Contractor Install. Husky C602H.

B. SCBA Compressor/Fill Station: Owner Provided, Contractor Install. Bauer Unicus 4i

2.04 FINISH

A. Provide manufacturer's stainless steel or as specified by Architect from manufacturers range of colors.

PART 3 - EXECUTION

3.01 COORDINATION

A. Fully coordinate with other trades all requirements for proper installation. Coordination includes, but is not limited to, the following:
   1. Utility rough-ins, including type, sizing, connections, and required locations.
   2. Kitchen Kitchen Range Hood: Hood over Fire Station range is a Type I Commercial Hood, and is not installed under the work of this Section. Refer to Division 23. However, coordinate range installation requirements with the hood installation, as applicable, including location and orientation of gas connection to allow range to be pushed flush against the rear supply plenum panel.
   3. Templates: Provide templates or other information as required for other trades to coordinate with approved equipment. Submit equipment and appliances submittal in time for review and approval as required to avoid impact to production schedules of other affected trades.
   4. Millwork: Fully coordinate all dimensions required to avoid conflicts between door and drawers and cabinet handles at inside cabinet corners and similar conditions that might affect function or ability to fully open doors and drawers, either on the millwork or the appliance / equipment. Fully coordinate clear dimensions required for appliances and equipment mounted in or adjacent to millwork to fit neatly, with required clearances and tolerances, and without sight gaps.
      a. Perform all such coordination prior to preparation of millwork shop drawings.
   5. Freestanding Equipment: Verify that clearances to as-constructed conditions are adequate to properly access and operate equipment.
   6. Confirm exact location for coffee makers and their connections with Owner in field.

B. Contractor shall not be due additional compensation to make modifications to rough-ins, millwork, clearances / dimensions, and similar conditions that may be required for satisfactory installation, that must be corrected due to Contractor’s failure to coordinate between trades.

3.02 INSTALLATION, GENERAL

A. General: Comply with manufacturer's instructions and recommendations.

B. Verify that accessory items required have been furnished.

C. Locate and install items as indicated in Drawings and to conceal utility attachments to the maximum extent possible.

D. Securely anchor units to supporting cabinetry or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

E. Built-in Equipment: Securely anchor units to supporting cabinets, countertops, or other adjacent construction as applicable, with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

F. Freestanding Equipment: Place units in final locations after finishes have been completed in each area.

G. Utilities: Refer to Divisions 22, 23 and 26 for plumbing, mechanical, and electrical requirements.

3.03 ADJUST AND CLEAN

A. Test each item of equipment to verify proper operation. Make necessary adjustments.

B. Verify that accessory items required have been furnished.

C. Remove packing material from equipment items and leave units in clean condition, ready for operation.

D. Comply with Division 01, "Construction Waste Management".

E. Retain Manufacturers' installation instructions and owner manuals, including for any Owner-Provided equipment installed by Contractor, for incorporation into the Operations and Maintenance Manuals.

F. Clean appliances and equipment prior to substantial completion, using materials and methods recommended by the Manufacturer of each item, and that will not damage items or finishes.

END OF SECTION 11 31 00

SECTION 12 24 00 - MANUAL ROLLER SHADES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes integrated motor control options for the following:
   1. Manual Roller Solar Shades

B. Related Documents: The Contract Documents, as defined in Division 1 Section "Summary of Work", apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections include the following:
   1. Division 6 Section “Rough Carpentry” for window shade bracket support blocking or pocket assemblies.

1.03 PERFORMANCE REQUIREMENTS

A. Fire: Provide shade fabrics tested in accordance with:
   1. 1989 NFPA 701 small scale Vertical Burn Test and rated “PASS”
   2. 1996 NFPA 701 small scale Vertical Burn (telephone booth test) and rated “PASS”

B. Toxicity: Provide shade fabrics tested in accordance with University of Pittsburgh Toxicity Protocol including LC50 analysis and toxicity characteristics.

C. Anti-microbial:
   1. ASTM G-22-80 results for ATCC6538 (Staphylococcus aureus) an ATCC13388 (Pseudomonas aeroginosa) indicating minimum 5mm (0.197 inches) “No Growth Contact Area”.
   2. ASTM G-21-85 results for ATCC9642, ATCC9348 and ATCC9645 indicating “No Growth”.

1.04 SUBMITTALS

A. Specification Conformance Document: Indicate whether the submitted equipment deviates from the specific requirements:
   1. Address or itemize compliance, or detail the alternate means submitted and indicate specific methodology used for Architect review & approval.

B. Product Data: Manufacturer's data sheets with performance specifications demonstrating compliance with specified requirements, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Submit manufacturer's descriptive literature and details for each product type specified. Details indicate materials, finishes, construction, and dimensions of individual components, profiles, and mounting requirements.
   4. Submit test reports indicating compliance with fabric properties specified.

C. Shop Drawings; include:
   1. Provide head, jamb and sill details, and relevant dimensions for mounting requirements for each product type and mounting condition.
   2. Provide shade schedule indicating room number, opening size(s), quantities and key to details.
   3. Provide one-line wiring system diagrams including connection details and overall arrangement of shades and control locations supplied by this section for installation and connection under division 26.

D. Selection Samples: For each finish product specified provide:
   1. Portfolio of shade fabric swatches for initial fabric color selection from manufacturer's full range of available fabrics.
   2. Material samples for color and finish selection of controls.

E. Verification Samples: For each finish product specified:
   1. One fully operational window shade sample of each type required complete with selected shade fabric including sample of seam / batten when applicable. Location of sample as directed by Architect.
   2. One complete set of all shade components demonstrating compliance with project requirements when applicable.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. The responsibility for the design, engineering, installation, and performance of motorized window shade systems specified will be assigned to a single manufacturer and their qualified dealers/installers.
   2. Minimum 5 years experience in manufacture of precision-engineered, low-voltage motorized shading systems.
   3. Furnish shading system and electrical control equipment for a complete installation and single source responsibility of shading and lighting control where applicable.

4. The manufacturer, subsidiary, or licensed agent will be qualified to supply the products specified and to honor any claims against the product presented in accordance with the warranty.
5. Provide 24-Hour / 7-Day technical support to troubleshoot system wiring and aid in system programming.

B. Installer Qualifications: Installer shall be qualified to install and commission the specified products by prior factory training, experience, demonstrated performance, and acceptance of any requirement of the manufacturer, subsidiary of the manufacturer, or licensed agent.

C. Do not fabricate shades without obtaining field dimensions for each opening. Coordinate construction of surrounding conditions to allow for timely field dimension verification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver items to the project until all plaster, painting and other wet work has been completed and is dry.

B. Deliver shades to project in labeled protective packaging, uniquely labeled to identify each shade for each opening. Schedule delivery to prevent delays to completion of work but to minimize on-site storage time.

C. Store materials in a dry, secure place. Protect from weather, surface contaminants, corrosion, construction traffic and all other potential damage.

1.07 PROJECT CONDITIONS

A. Maintain environmental conditions within recommended limits:
1. Ambient operating temperature: 32–72 °F
2. Humidity: 0–90%, non-condensing.
3. Do not install products under environmental conditions outside manufacturer's absolute limits.
4. Products are intended for Indoor use only.

B. Shade system shall not be installed until the building is operating at ambient temperature and humidity ranges that are consistent with those intended for eventual building occupancy & use.

1.08 COORDINATION

A. Contractor shall coordinate installation of the following items with the window shade contractor:

B. Contractor shall provide the following materials and services to the window shade contractor for electrically powered window treatments:
   1. Power wiring in accordance with requirements provided by the window shade contractor or electrical contractor.
   2. Low-voltage wiring as necessary for operation of shade control system with requirements provided by the window shade or electrical contractor.

C. Scheduling:
   1. Fabricate shades after obtaining field dimensions for each opening.
   2. Coordinate construction of surrounding conditions to allow for timely field dimension verification.
   3. Manufacturer's standard lead times apply. Reference submittal and schedule accordingly for project timeline.

1.09 WARRANTY

A. Shade motors and motor control system electrical components: Provide manufacturer's Warranty under provisions of Division 1 Section "General Requirements". Warranty period shall be 8 years (limited, pro-rated) from Date of Substantial Completion, and 2 years (full, 100%) for all components. Warranty period shall include all operating parts.

B. Shadecloth and all other components of shade system are Warranted to be fit for the use intended for a minimum of 5 years.

C. In the event of a warranted product failure, the Shade Contractor will, at no cost to Owner, facilitate acquisition and delivery of all necessary components to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of design: Quality, design, and desired function are based on Lutron "RollEase Clutch System" manual shade products by Lutron Shading Systems, Inc., Coopersburg, PA (888) 588-7661. Other approved manufacturers include:
   1. Draper, Inc. "Clutch Operated Flexshade"

B. Substitutions: Under provisions of Division 1.
   1. All proposed substitutions must be clearly delineated, and must be submitted in writing for approval by Architect a minimum of 10 working days prior to the bid date, and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2.02 SYSTEM REQUIREMENTS

A. Aesthetics
   1. Symmetrical light gaps of no more than 0.75 inch typical or 0.625 inch minimum.
   2. Shade mounting position can be adjusted while the shade is installed to ensure perfect shade centering.

2.03 ROLLER SHADES

A. Fabrics:
   1. Fabric #1 (all other locations):
      a. SheerShade, Basketweave XL, “Linen,” 3%.
   2. Fabric #2 (all sleeping rooms):
      a. Blackout, Value Premiere, "Sand”.

B. Shade Tube:
   1. Fabric shall be connected to the tube with double-sided adhesive strip applied for exact and firm mounting of fabric and easy adjustment to prevent telescoping.
   2. To protect fabric and smooth out starting seam, a minimum one turn of fabric shall be placed on the roller before the working section of fabric starts.
   3. Bottom Bar: Standard Sealed bottom Bar shall be a 10 inch wide by 0.1875 inch thick, extruded aluminum bar, enclosed on all sides in thermally sealed pocket across bottom of shading fabric.

C. Pull Chain:
   1. Provide Stainless Steel pull chain meeting ANSI/ WCMA A100.1-2014 5.2.4 safety guidelines.
   2. Mount to Wall.
   3. Route Pull-Chain appropriately to suit mounting application, with fascia.

2.04 SHADE MOUNTING / ENCLOSURE

A. General:
   1. Roller shade brackets to provide symmetrical gaps of 0.75inch (20 mm) on each side of shade
   2. Provide 2-piece mounting bracket for leveling, projection, and shade centering adjustments that allows adjustment while roller shades are mounted to the brackets.
   3. A single EDU shall be capable of driving multiple shades with a coupling pin.
   4. Coupling pin shall allow for precision adjustment of bottom bar levels without removing roller from its installed point, or removing fabric from roller tube.

B. Mounting:

1. Inside/Jamb Mount: Provide window system jamb-mounting, with 2-piece brackets.
2. Provide Fascia kit suited to mounting applications.
   a. Finish: Silver.

C. Options for blackout condition:
1. Side Channel.
2. Sill Angle.

2.05 SOURCE QUALITY CONTROL

A. Perform full-function testing on all completed assemblies at end of production line prior to shipment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Begin installation after substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install shades in windows level and plumb to provide smooth operation.

C. Install in accordance with manufacturer’s product data and approved shop drawings.

D. A factory-qualified technician shall perform field measurement and installation.

3.04 ADJUSTING

A. Adjust the level, projection, and shade centering directly from mounting bracket.

B. Adjust fabric on tube if visibly telescoping.

C. Adjust blackout roller shades and accessories to effectively block all natural light from entering the room.

3.05 CLEANING

A. Touch up damaged finishes and repair minor damage in order to eliminate evidence of repair. Remove and replace work that cannot be satisfactorily repaired.

B. Clean exposed surfaces, including metal and shade fabric, using non-abrasive materials and methods recommended by the shade fabric manufacturer. Remove and replace work that cannot be satisfactorily cleaned.

3.06 DEMONSTRATION

A. Demonstrate operation method and instruct owner's personnel in the proper operation and maintenance of the window shade systems.

B. Manufacturer’s Instructions:
   1. Installation, Programming, and Maintenance instructions to be included in product packaging.
   2. 24-Hour / 7-Day Factory Technical Support shall be available to aid with unforeseen installation difficulties.

3.07 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion

END OF SECTION 12 24 00

SECTION 141200 – ELECTRIC DUMBWAITER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes power dumbwaiters and self-supporting dumbwaiter structures.

B. Related sections include the following.
   1. Division 05 Section "Cold-Formed Metal Framing."
   2. Division 09 Section "Painting."
   3. Division 09 Section "Gypsum Board."
   4. Division 26 Sections for electrical service to dumbwaiters, including disconnect switches.

1.03 PERFORMANCE REQUIREMENTS

A. Speed: 50 fpm.

B. Capacity: 300 lbs.

C. Car size: 30 inches wide by 30 inches deep by 40 inches high.

D. Doors: Bi-Parting

E. Stops: 2

F. Openings: 2 (1 at each level, same side), height as indicated on drawings.

1.04 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, Controls, finishes for dumbwaiters.

B. Shop Drawings: Include plans, elevations, sections, details and attachments to other work.

C. Samples for initial selection: For units with factory-applied color finishes.

D. Product certificates for each type of dumbwaiter, signed by product manufacturer.

E. Qualification Data: for installer.

F. Operation and Maintenance data: for dumbwaiters to include in emergency, operations and maintenance manual.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Dumbwaiter manufacturer or qualified installer approved by dumbwaiter manufacturer.

B. Regulatory Requirements: Comply with ASME A17.1 & CSA B44 Codes.

C. Fire Rated Door Assemblies: Door and frame assemblies comply with NFPA 80 that are listed and labeled by a testing and inspection agency acceptable to authorities having jurisdiction, for the fire-protection ratings indicated, based on testing at as neutral pressure as possible according to NFPA 252.
   1. Hoistway Door Rating: As indicated on drawings.
   2. Access Door Rating: As indicated on drawings.

D. Electrical Components, Devises and Accessories: Listed and labeled as defined in NFPA 70 article 100, by a testing agency acceptable to authorities having Jurisdiction and marked for intended use.

1.06 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at substantial completion, provide one year's full maintenance service by skilled employee of dumbwaiter installer. Include monthly preventive maintenance, repair or replace worn or defective components, lubrication, cleaning and adjusting as required for proper dumbwaiter operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Elevation Innovation Inc. (877) 345-4387 www.eilifts.com

2.02 MATERIALS AND COMPONENTS

A. General: Provide manufacturer's standard pre-engineered dumbwaiters. Where not otherwise indicated, provide manufacturer's products as indicated in published product literature as required for complete dumbwaiter system.

B. Systems and machinery:
   1. Driving Machine Type: Manufacturer's standard – winding drum.
   2. Hardware: Attachments required for fastening guide-rail and other dumbwaiter components to structural building framing.
   3. Machine Location: Locate dumbwaiter machine inside shaft at bottom of hoistway.
   4. Electrical Requirements: As indicated on drawings, coordinate with manufacturer's power requirements, and notify Architect immediately of any discrepancies.

C. Control system: Fully automatic allowing car to be sent or called from any floor. Terminal limit switch provided for by final. Car stop is automatic at landing levels. Door interlocks for hoistway doors to prevent operation of the dumbwaiter unless doors are closed and to prevent opening of any door except when the car is at that landing.

D. Leveling tolerance: Provide car stopping system with ½ - inch (13mm) leveling Tolerance, regardless of load or direction of travel.

E. Provide the following materials and finishes for exposed surfaces of dumbwaiter car, enclosures, car doors, hoistway doors and frames and signal equipment.
   a. Stainless Steel.

F. Car construction: Manufacturer's standard.

G. Hoistway Doors and Frames: Manufacturer's standard
   1. Frames: Stainless Steel
      a. Frames of depth and profile indicated to coordinate with hoistway wall construction.
      b. Formed metal sill members of not less than 0.0598-inch(1.5mm) thickness.
      c. Frame material: Stainless Steel
      d. Doors: Bi-Parting Stainless Steel
      e. Car Gate: Bi-Parting Stainless Steel

H. Signal Equipment: Manufacturer's standard signal equipment at each landing push-button station; include call / send button for each landing served, and illuminated "car- in-use" and arrival flashing signal.

2.03 FINISHES GENERAL

A. Comply with NAAMM's "Metal finishes manual for architectural and metal products" for recommendations for applying and designating finishes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with installer present, for compliance with requirements for hoistway installation tolerances and other conditions affecting performance at work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Alignment: Coordinate hoistway doors with dumbwaiter travel and car positioning for accurate alignment and minimum clearance between car, hoistway doors, sills, and door frame at each level.

C. Lubricate operating parts of dumbwaiter to manufacturer's recommendation.

3.03 FIELD QUALITY CONTROL

A. Test-operate dumbwaiter continuously between lowest and highest landings served, hoisting full rated capacity load for a minimum of 30 minutes. Re- adjust car tops and other devices and signal equipment for accurate landings and operation of systems after completing test.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owners maintenance personnel to operate, adjust and maintain dumbwaiters.

END OF SECTION 14 12 00

SECTION 21 05 23 - GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bronze butterfly valves with indicators.
2. Check valves.
3. Iron OS&Y gate valves.
4. NRS gate valves.
5. Trim and drain valves.

1.3 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.
    a. Level 1: HCBZ - Indicator Posts, Gate Valve.
    b. Level 1: HLOT - Valves.
        1) Level 3: HLUG - Ball Valves, System Control.
        2) Level 3: HLXS - Butterfly Valves.
        3) Level 3: HMER - Check Valves.
        4) Level 3: HMRZ - Gate Valves.
2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
    a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:
    a. Indicator posts.
    b. Valves.
        1) Gate valves.
        2) Check valves.
            a) Single check valves.
        3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Milwaukee Valve Company.

B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze Stainless steel with EPDM coating.
7. Actuator: Worm gear or traveling nut.
8. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
9. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.3 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kennedy Valve Company; a division of McWane, Inc.
2. NIBCO INC.
3. Victaulic Company.

B. Description:
   1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
   2. Minimum Pressure Rating: 175 psig.
   3. Type: Single swing check.
   4. Body Material: Cast iron, ductile iron, or bronze.
   5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
   6. Clapper Seat: Brass, bronze, or stainless steel.
   7. Hinge Shaft: Bronze or stainless steel.
   8. Hinge Spring: Stainless steel.
   9. End Connections: Flanged, grooved, or threaded.

2.4 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Kennedy Valve Company; a division of McWane, Inc.
   2. Mueller Co.
   3. NIBCO INC.

B. Description:
   1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
   2. Minimum Pressure Rating: 175 psig.
   3. Body and Bonnet Material: Cast or ductile iron.
   4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
   5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
   6. Stem: Brass or bronze.
   7. Packing: Non-asbestos PTFE.
   8. End Connections: Flanged Grooved Threaded.

2.5 NRS GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Kennedy Valve Company; a division of McWane, Inc.
   2. Mueller Co.

B. Description:
   1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
   2. Minimum Pressure Rating: 175 psig.
   3. Body and Bonnet Material: Cast or ductile iron.
   4. Wedge: Cast or ductile iron with elastomeric coating.
   5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.

6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. End Connections: Flanged Grooved Threaded.

2.6 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Victaulic Company.
2. Description:

    a. Pressure Rating: 175 psig.
    b. Body Design: Two piece.
    c. Body Material: Forged brass or bronze.
    d. Port size: Full or standard.
    e. Seats: PTFE.
    f. Stem: Bronze or stainless steel.
    g. Ball: Chrome-plated brass.
    h. Actuator: Handlever.
    i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
    j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. NIBCO INC.
    b. United Brass Works, Inc.
2. Description:

    a. Pressure Rating: 175 psig.
    b. Body Material: Brass or bronze.
    c. Ends: Threaded.
    d. Stem: Bronze.
    e. Disc: Bronze.
    f. Packing: Asbestos free.
    g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. NIBCO INC.
b. United Brass Works, Inc.

2. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
2. Section 21 12 00 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
3. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
4. Section 21 13 16 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.

5. Section 21 13 39 "Foam-Water Systems" for application of valves in AFFF piping.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 21 05 23

SECTION 21 05 29 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 21 05 16 "Expansion Fittings and Loops for Fire-Suppression Piping" for pipe guides and anchors.
3. Section 21 05 48.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices .

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

1.5 QUALITY ASSURANCE

A. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 13.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel **<Insert material>**.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. Simpson Strong-Tie Co., Inc.

2.5 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.6 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size,or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms,and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
         Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and attachments for general service applications.

F. Use thermal hanger-shield inserts for insulated piping and tubing.

G. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Hanger-Rod Attachments: Comply with NFPA requirements.

J. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

K. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

L. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Sprinklers.

B. Related Requirements:

1. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 23 05 23 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 250 psig.

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling include the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.

B. Qualification Data: For qualified Installer.

C. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

   1. NFPA 13.
   2. NFPA 13R.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Thinwall Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

D. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

E. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M thinwall with plain ends and wall thickness less than Schedule 10.

F. Hybrid Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.

G. Schedule 5 Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M lightwall with plain ends.

H. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

I. Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

J. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick EPDM rubber gasket.

    a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

K. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Anvil International.
    b. Tyco Fire Products LP.
    c. Victaulic Company.
2. Pressure Rating: 175-psig minimum.
3. Painted Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

2.4 CPVC PIPE AND FITTINGS

A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F, with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.

B. CPVC Fittings: UL listed, for 175-psig rated pressure at 150 deg F, socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.

1. NPS 3/4 to NPS 1-1/2: ASTM F 438 and UL 1821, Schedule 40, socket type.
2. NPS 2 to NPS 3: ASTM F 439 and UL 1821, Schedule 80, socket type.

C. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.

D. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco Fire Products LP.
4. Victaulic Company.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

F. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

G. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
   1. Nominal Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
   2. Nominal Orifice: 17/32 inch with discharge coefficient K between 7.4 and 8.2.

H. Sprinkler Finishes: bronze and painted.

I. Special Coatings: corrosion-resistant paint.

J. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

   1. Ceiling Mounting: Plastic, white finish, one piece, flat.
   2. Sidewall Mounting: Plastic, white finish, one piece, flat.

K. Sprinkler Guards:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Reliable Automatic Sprinkler Co., Inc. (The).
      b. Tyco Fire Products LP.
   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 22 11 16 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

N. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices air compressors.

O. Fill sprinkler system piping with water.

P. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 21 05 33 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 21 07 00 "Fire-Suppression Systems Insulation."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

Q. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

R. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

S. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.7 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.8 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.9 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain .

3.13 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. or, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. or, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
   4. or, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
   5. or, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   6. or, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   7. or, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   8. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   9. or black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
   10. or black-steel pipe with plain ends; welding fittings; and welded joints.
   11. , hard copper tube with plain ends; cast-copper, solder-joint fittings; and brazed joints.
   12. , hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   13. NPS 2,, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. or, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. or, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. or, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. or, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. or, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. or black-steel pipe with plain ends; welding fittings; and welded joints.
8. , hard copper tube with plain ends; cast-copper, solder-joint fittings; and brazed joints.
9. , hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
10. , hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
1. or, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. or, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. or, black-steel pipe with **[or]** roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. or, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. or, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. or black-steel pipe with plain ends; welding fittings; and welded joints.
8. , hard copper tube with plain ends; cast-copper, solder-joint fittings; and brazed joints.
9. , hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

3.14 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.

3. Special Applications: Attic sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal fittings.
3. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

A. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.2 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

2. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6: PVC-pipe sleeves.

3. Interior Partitions:
    a. Piping Smaller Than NPS 6: PVC-pipe sleeves.

END OF SECTION 22 05 17

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.

END OF SECTION 22 05 18

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron ball valves.
4. Iron, grooved-end butterfly valves.
5. Bronze swing check valves.
6. Iron swing check valves.

B. Related Sections:

1. Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 22 11 16 "Domestic Water Piping" for valves applicable only to this piping.
3. Section 22 13 19 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.
4. Section 22 15 13 "General-Service Compressed-Air Piping" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inchstem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco
b. Milwaukee
c. Apollo

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.
j. Port: Full.

B. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco
b. Millwaukee
c. Apollo

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco
b. Millwaukee
c. Apollo

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

B. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Nibco
   b. Milwaukee
   c. Apollo

2. Description:

   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Three piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Nibco
   b. Millwaukee
   c. Apollo

2. Description:

   a. Standard: MSS SP-72.
   b. CWP Rating: 200 psig.
   c. Body Design: Split body.
   d. Body Material: ASTM A 126, gray iron.
   e. Ends: Flanged.
   f. Seats: PTFE or TFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
   i. Port: Full.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Nibco
    b. Millwaukee
    c. Apollo

2. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 175 psig.
    c. Body Material: Coated, ductile iron.
    d. Stem: Two-piece stainless steel.
    e. Disc: Coated, ductile iron.
    f. Seal: EPDM.

2.6 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Nibco
    b. Millwaukee
    c. Apollo

2. Description:

    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 200 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Nibco
    b. Millwaukee
    c. Apollo

2. Description:

    a. Standard: MSS SP-80, Type 4.
    b. CWP Rating: 200 psig.

c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco
b. Millwaukee
c. Apollo

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE or TFE.
j. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2and Smaller: Bronze swing check valves with nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5and Larger: Flanged ends.
4. For Steel Piping, NPS 2and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Pipe NPS 2and Smaller:

1. Ball Valves: Three piece, full port, brass with stainless-steel trim.
2. Bronze Lift Check Valves: Class 125, nonmetallic disc.
3. Bronze Swing Check Valves: Class 150, nonmetallic disc.

3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2and Smaller:

1. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
2. Bronze Swing Check Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2and Larger:

1. Iron Ball Valves: Class 150.
2. Iron, Grooved-End Butterfly Valves: 175 CWP.
3. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
4. Iron, Grooved-End Swing Check Valves: 300 CWP.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.
8. Paint Coating: Epoxy.
9. Plastic Coating: PVC.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inchesbeyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 91 23 "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24if little or no insulation is required.
3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inchesfor heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg Fpiping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Brady or comparable product by one of the following:

    a. Seton

3. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
4. Letter Color: White.
5. Background Color: Black.
6. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
7. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

8. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
9. Fasteners: Stainless-steel self-tapping screws.
10. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inchbond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Brady or comparable product by one of the following:

1. Seton

C. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Brady or comparable product by one of the following:

1. Seton

C. Valve Tags: Stamped or engraved with 1/4-inchletters for piping system abbreviation and 1/2-inchnumbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inchbond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. High-Pressure Compressed Air Piping:

    a. Background: Safety blue.
    b. Letter Colors: White.

2. Domestic Water Piping:

    a. Background: Safety green.
    b. Letter Colors: White.

3. Sanitary Waste Piping:

    a. Background Color: Safety black.
    b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

    a. Cold Water: 2 inches, round.
    b. Hot Water: 2 inches, round.
    c. High-Pressure Compressed Air: 1-1/2 inches, round.

2. Valve-Tag Colors:

    a. Cold Water: Safety green.
    b. Hot Water: Safety green.
    c. High-Pressure Compressed Air: Safety blue.

3. Letter Colors:

    a. Cold Water: White.
    b. Hot Water: White.
    c. High-Pressure Compressed Air: White.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Sanitary waste piping exposed to freezing conditions.

B. Related Sections:

1. Section 22 07 16 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Owens Corning

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Owens Corning

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Owens Corning

2. Type I, 850 Deg FMaterials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 permat 43-mildry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 permat 35-mildry film thickness.
2. Service Temperature Range: 0 to 180 deg F.

3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 permat 30-mildry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 permsat 0.0625-inchdry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd.with a thread count of 10 strands by 10 strands/sq. in.for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd.with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.

2. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inchin width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inchin width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.

3. Adhesion: 64 ounces force/inchin width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inchin width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inchin width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inchin width.

2.12 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inchthick, 1/2 inch wide with wing seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inchthick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inchsoft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 milsthick and an epoxy finish 5 milsthick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg Fwith an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 incheso.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches**][**4 inches**] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inchesbeyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut

sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or

union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inchesover adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 incheso.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 incheso.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inchoverlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inchlaps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inchoverlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inchoverlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 incheso.c. and at end joints.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches thick.

D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. PVC: 20 mils thick.

D. Piping, Exposed:

1. 30 mils thick.
2. Aluminum, smooth: 0.016 inch thick.

END OF SECTION 22 07 19

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:

1. Section 22 11 13 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

F. Copper Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Viega
   b. Nibco

2. Fittings for NPS 2and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

G. Appurtenances for Grooved-End Copper Tubing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Victaulic

2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:

   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating: 300 psig.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inchthick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psigminimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psigminimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.

4. Pressure Rating and Temperature: 300 psigat 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

F. Install domestic water piping level without pitch and plumb.

G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

P. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

Q. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."

R. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2and Smaller: Fitting-type coupling.
2. Fittings for NPS 2and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2and Smaller: Plastic-to-metal transition unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feetand Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feetif Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feetor Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4and Smaller: 60 incheswith 3/8-inchrod.
2. NPS 1 and NPS 1-1/4: 72 incheswith 3/8-inchrod.
3. NPS 1-1/2 and NPS 2: 96 incheswith 3/8-inchrod.
4. NPS 2-1/2: 108 incheswith 1/2-inchrod.
5. NPS 3 to NPS 5: 10 feetwith 1/2-inchrod.
6. NPS 6: 10 feetwith 5/8-inchrod.
7. NPS 8: 10 feetwith 3/4-inchrod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4and Smaller: 84 incheswith 3/8-inchrod.
2. NPS 1-1/2: 108 incheswith 3/8-inchrod.
3. NPS 2: 10 feetwith 3/8-inchrod.
4. NPS 2-1/2: 11 feetwith 1/2-inchrod.
5. NPS 3 and NPS 3-1/2: 12 feetwith 1/2-inchrod.
6. NPS 4 and NPS 5: 12 feetwith 5/8-inchrod.
7. NPS 6: 12 feetwith 3/4-inchrod.

8. NPS 8 to NPS 12: 12 feetwith 7/8-inchrod.

G. Install supports for vertical steel piping every 15 feet.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppmof chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppmof chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 3and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K; copper pressure-seal fittings; and pressure-sealed joints.

D. Under-building-slab, domestic water piping, NPS 2and smaller, shall be [**one of**] the following:

1. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be [**one of**] the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.

END OF SECTION 22 11 16

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Gaskets: ASTM C 564, rubber.

B. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

D. Solvent Cement: ASTM D 2564.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design

considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3and smaller; 1 percent downward in direction of flow for piping NPS 4and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install aboveground PVC piping according to ASTM D 2665.

P. Install underground PVC piping according to ASTM D 2321.

Q. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. Install individual, straight, horizontal piping runs:

    a. 100 Feetand Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feetif Indicated: MSS Type 49, spring cushion rolls.

6. Multiple, Straight, Horizontal Piping Runs 100 Feetor Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inchminimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 incheswith 3/8-inchrod.
2. NPS 3: 60 incheswith 1/2-inchrod.
3. NPS 4 and NPS 5: 60 incheswith 5/8-inchrod.
4. Spacing for 10-footlengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 incheswith 3/8-inchrod.
2. NPS 1-1/2: 108 incheswith 3/8-inchrod.
3. NPS 2: 10 feetwith 3/8-inchrod.
4. NPS 2-1/2: 11 feetwith 1/2-inchrod.
5. NPS 3: 12 feetwith 1/2-inchrod.
6. NPS 4 and NPS 5: 12 feetwith 5/8-inchrod.

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 incheswith 3/8-inchrod.
2. NPS 3: 48 incheswith 1/2-inchrod.
3. NPS 4 and NPS 5: 48 incheswith 5/8-inchrod.

J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, vent piping NPS 4and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, soil, waste, and vent piping NPS 4and smaller shall be the following:

1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Underground, soil and waste piping NPS 5and larger shall be the following:

1. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Trench drains.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts Refer to Plumbing Fixture Schedule on drawings.:

1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
2. Size: Same as connected drainage piping
3. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts Refer to Plumbing Fixture Schedule on drawings.:

1. ASME A112.36.2M, Cast-Iron Cleanouts:
2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
3. Size: Same as connected branch.
4. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts Refer to Plumbing Fixture Schedule on drawings.:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains Refer to Plumbing Fixture Schedule on drawings:

1. Standard: ASME A112.6.3.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Outlet: Bottom.

2.3 TRENCH DRAINS

A. Trench Drains Refer to Plumbing Fixture Schedule on drawings.:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASME A112.6.3 for trench drains.
3. Material: Ductile or gray iron.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies.:

1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

    a. Open-Top Vent Cap: Without cap.
    b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
    c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies.:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.

3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Sleeve Flashing Device.:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

B. Stack Flashing Fittings.:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

C. Vent Caps.:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inchthickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inchthickness.
3. Burning: 6-lb/sq. ft., 0.0938-inchthickness.

B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-milminimum thickness.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feetfor piping NPS 4and smaller and 100 feetfor larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inchesor Less: Equivalent to 1 percent slope, but not less than 1/4-inchtotal depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inchesor Larger: Equivalent to 1 percent slope, but not greater than 1-inchtotal depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inchclearance between vent pipe and roof substrate.

L. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

M. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Section 23 11 13 "Facility Fuel-Oil Piping."

N. Install wood-blocking reinforcement for wall-mounting-type specialties.

O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

D. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

E. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inchthickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inchthickness or thinner.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."

E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

   1. Grease interceptors.
   2. Oil interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 13 23 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grease interceptors.
2. Oil interceptors.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For each type and size of precast-concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Grease Interceptors: Precast concrete complying with ASTM C 913.

1. Structural Design Loads:

a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).

2. Manhole Frames and Covers: Ferrous; 24-inchID by 7- to 9-inchriser with 4-inch-minimum width flange and 26-inch-diameter cover.

a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
c. Include indented top design with lettering cast into cover, using wording equivalent to " GREASE INTERCEPTOR."

B. Capacities and Characteristics: Refer to Plumbing Details on Drawings

2.2 OIL INTERCEPTORS

A. Oil Interceptors: Precast concrete comply with ASTM C 913.

1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
2. Structural Design Loads:

    a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).

3. Grade Rings: Reinforced-concrete rings, 6- to 9-inchtotal thickness, to match diameter of manhole frame and cover.
4. Manhole Frames and Covers: Ferrous; 24-inchID by 7- to 9-inchriser with 4-inch-minimum width flange and 26-inch-diameter cover.

    a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
    b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
    c. Include indented top design with lettering cast into cover, using wording equivalent to " OIL INTERCEPTOR."

B. Capacities and Characteristics: Refer to Plumbing Details on drawings.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 INSTALLATION

A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Set tops of grating frames and grates flush with finished surface.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Section 31 20 00 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 22 13 23

SECTION 22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Commercial, electric, storage, domestic-water heaters.
2. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including storage tank and supports.
    b. Faulty operation of controls.
    c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

    a. Commercial, Electric, Storage, Domestic-Water Heaters:

        1) Storage Tank: Three years.
        2) Controls and Other Components: Three years.

    b. Compression Tanks: 3 years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, undefined:

a. A. O. Smith Corporation.
b. Rheem Manufacturing Company.
c. State Industries.
d. Bradford White

2. Standard: UL 1453.
3. Storage-Tank Construction:ASME-code, steel vertical arrangement.

a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

b. Pressure Rating: 150 psig.
c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
c. Insulation: Comply with ASHRAE/IESNA 90.1.
d. Jacket: Steel with enameled finish.
e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
f. Temperature Control: Adjustable thermostat.
g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A. O. Smith Corporation.
b. State Industries.

2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.
4. Capacity and Characteristics:

    a. Working-Pressure Rating: 150 psig.
    b. Capacity Acceptable: 4 gal. minimum.
    c. Air Precharge Pressure: .

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Electric, Domestic-Water Heater Mounting: Install residential, electric, domestic-water heaters on floor.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

I. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

J. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

K. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 22 11 19 "Domestic Water Piping Specialties."

L. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

M. Fill electric, domestic-water heaters with water.

N. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

END OF SECTION 22 33 00

SECTION 22 41 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Lavatories.
2. Showers.
3. Kitchen sinks.
4. Water closets.
5. Toilet seats.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LAVATORIES

A. Lavatories Refer to Plumbing Fixture Schedule on drawings.: Oval, vitreous china, counter mounted.

1. Vitreous-China Lavatories:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Refer to Plumbing Fixture Schedule on drawings.

2. Fixture:

a. Standard: ASME A112.19.2/CSA B45.1 for vitreous-china lavatories.

2.2 SHOWERS

A. Showers Refer to Plumbing Fixture Schedule on drawings.: Standard

1. Standard: ANSI Z124.1.2.

2.3 KITCHEN SINKS

A. Kitchen Sinks Refer to Plumbing Fixture Schedule on drawings.: Two bowl, counter mounted, stainless steel.

1. Stainless-Steel Kitchen Sinks:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Refer to Plumbing Fixture Schedule on drawings.

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4 for stainless-steel kitchen sinks.

2.4 WATER CLOSETS

A. Water Closets Refer to Plumbing Fixture Schedule on drawings..

1. Bowl:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.

2.5 TOILET SEATS

A. Toilet Seats Refer to Plumbing Fixture Schedule on drawings.:

1. Standard: IAPMO/ANSI Z124.5.

2.6 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install plumbing fixtures level and plumb according to roughing-in drawings.

B. Install floor-mounted water closets on closet flange attachments to drainage piping.

C. Install counter-mounting fixtures in and attached to casework.

D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

E. Install toilet seats on water closets.

F. Install shower flow-control fittings with specified maximum flow rates in shower arms.

G. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes unless otherwise indicated.

H. Set shower receptors in leveling bed of cement grout.

I. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

J. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 41 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and poly phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal fittings.
3. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

A. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

B. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.2 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

2. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: PVC-pipe sleeves

3. Interior Partitions:
   a. Piping Smaller Than NPS 6: PVC-pipe sleeves.

END OF SECTION 23 05 17

SECTION 23 05 48.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric hangers.
3. Spring hangers.

B. Related Requirements:

1. Section 21 05 48.13 "Vibration Controls for Fire Suppression" for devices for fire-suppression equipment and systems.
2. Section 22 05 48.13 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Waffle pattern.
6. Sandwich-Core Material: Resilient

    a. Surface Pattern: Waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.3 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 Cast-in-Place Concrete.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 23 05 48.13

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Stencils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements.

2. Material and Thickness: Brass, 0.032-inch, stainless steel, 0.025-inch, aluminum, 0.032-inch, or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black
4. Background Color: Red or White
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inchbond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 STENCILS

A. Stencils for Ducts:

1. Manufacturers: Subject to compliance with requirements:

2. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiberboard
4. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Manufacturers: Subject to compliance with requirements:

2. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiberboard
4. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in [Section 09 91 23 "Interior Painting."][Section 09 96 00 "High-Performance Coatings."]

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 15 feet along each run. Reduce intervals to in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background
2. Refrigerant Piping: Black letters on a safety-orange background

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

C. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB and must be 3rd party.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager and Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 23 31 13 "Metal Ducts" and Section 23 31 16 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Construction Manager and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.7 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.8 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Fan drive settings including settings and percentage of maximum pitch diameter.
    e. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

    1. Quantities of outdoor, supply, return, and exhaust airflows.
    2. Duct, outlet, and inlet sizes.
    3. Balancing stations.
    4. Position of balancing devices.

E. Fan-Coil-Unit Test Reports: For fan-coil units with coils, include the following:

    1. Unit Data:

        a. Unit identification.
        b. Location.
        c. Make and type.
        d. Model number and unit size.
        e. Manufacturer's serial number.
        f. Unit arrangement and class.
        g. Discharge arrangement.
        h. Sheave make, size in inches, and bore.
        i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
        j. Number, make, and size of belts.
        k. Number, type, and size of filters.

    2. Motor Data:

        a. Motor make, and frame type and size.
        b. Horsepower and rpm.
        c. Volts, phase, and hertz.
        d. Full-load amperage and service factor.
        e. Sheave make, size in inches, and bore.
        f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

    3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Cooling-coil static-pressure differential in inches wg.
g. Heating-coil static-pressure differential in inches wg.
h. Outdoor airflow in cfm.
i. Return airflow in cfm.
j. Outdoor-air damper position.
k. Return-air damper position.

F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Air flow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.10 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Verify that balancing devices are marked with final balance position.
    e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Construction Manager and Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager and Commissioning Authority.
3. Construction Manager and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, concealed return located in unconditioned space.
3. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
4. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:

1. Section 23 07 16 "HVAC Equipment Insulation."
2. Section 23 07 19 "HVAC Piping Insulation."
3. Section 23 31 13 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a **2**-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.4 MASTICS

A. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 permat 43-mildry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. Vinyl Jacket: White vinyl with a permeance of 1.3 permswhen tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inchin width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inchin width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or [Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inchgalvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Base plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Base plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Base plate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, nylon sheet, 0.030 inchthick by 1-1/2 inchesin diameter.
   b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Base plate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to

point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over compress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inchoutward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg Fat 18-footintervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over compress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inchoutward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg Fat 18-footintervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 "Penetration Firestopping."

3.7 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, concealed return located in unconditioned space.
3. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
4. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Flexible connectors.
3. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. Ft. nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches 0.75-lb/cu. Ft. nominal density.

E. Concealed, rectangular, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. Ft. nominal density.

F. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket; thickness as required to achieve 2-hour fire rating.

END OF SECTION 23 07 13

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Section 23 07 13 "Duct Insulation."
2. Section 23 07 16 "HVAC Equipment Insulation."
3. Section 23 21 13.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.
4. Section 33 63 13 "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

G. Mineral-Fiber, Preformed Pipe Insulation:

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 permat 30-mildry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.5 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or [Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inchnickel-copper alloy.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 milsthick and an epoxy finish 5 milsthick if operating in a temperature range

between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg Fwith an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to

point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inchesbeyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inchesover adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: 2 inches thick.

3.12 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 23 21 13.13 "Underground Hydronic Piping" and Section 33 63 13 "Underground Steam and Condensate Distribution Piping."

END OF SECTION 23 07 19

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Section 01 21 00 "Allowances."

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

1.8 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least **10** days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing **Subcontractor 10** days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing **Subcontractor** shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R **Subcontractor**, testing and balancing **Subcontractor**, and HVAC&R Instrumentation and Control **Subcontractor** shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R **Subcontractor** shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

D. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

G. All Supply / Return and Exhaust Air Systems

H. All HVAC&R piping systems

END OF SECTION 23 08 00

SECTION 23 09 00 BAS - INSTRUMENTATION AND CONTROL

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. SECTION 23 09 13, BAS Instrumentation and Control Devices

B. SECTION 23 09 13.13, BAS Actuators and Operators

C. SECTION 23 09 13.23, BAS Sensors and Transmitters

D. SECTION 23 09 13.43, BAS Control Dampers

E. SECTION 23 09 23, BAS Direct Digital Control System

1.2 REFERENCES

A. American National Standards Institute (ANSI)
   1. ANSI/ISA 5.5-1985 Graphic Symbols for Process Displays.
   2. ANSI/IEEE 260.1 2004, Standard Letter Symbols for SI and Certain Other Units of Measurements (SI Units, Customary Inch Pound Units and Certain Other Units).

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Acronyms used in BAS.
   1. BAS – Building Automation System
   2. EMCS – Energy Management and Control System
   3. GUI – Graphical User Interface
   4. HVAC - Heating, Ventilation, Air Conditioning
   5. I/O - Input/output
   6. ISA - Industry Standard Architecture
   7. O&M - Operation and Maintenance

1.4 PERMITS AND FEES

A. In accordance with General Conditions of Contract.

B. Submit certificate of acceptance from authority having jurisdiction to Owner.

1.5 GENERAL DESCRIPTION

A. Refer to control schematics for general system architecture.

B. Work covered by sections referred to above consists of fully operational BAS, including, but not limited to, following:
   1. Control devices as listed in I/O Summaries.
   2. Peripheral devices.

3. Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.
4. Acceptance tests, technical support during commissioning, full documentation.
5. Wiring interface co-ordination of equipment supplied by others.
6. Miscellaneous work as specified in these sections and as indicated.

1.6 US CUSTOMARY MEASUREMENT REFERENCES

A. Conform to NIST Handbook 44 - 2014 Edition Appendix C "General Tables of Units of Measurement"

B. Provide required adapters between US Customary and Metric components.

1.7 STANDARDS COMPLIANCE

A. All equipment and material to be from manufacturer's regular production, UL and/or ULC or CSA certified, manufactured to standard quoted plus additional specified requirements.

B. Where UL and/or ULC or CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

C. Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

D. In lieu of such evidence, submit certificate from testing organization, approved by Owner, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

E. For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

F. Sustainable Design:
   1. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.8 WORK INCLUDED

A. Provide a new building system to control and monitor the building's mechanical and electrical systems.

B. Provide control valves, control dampers (gravity, fire and smoke control dampers by others), flow switches, thermal wells for temperature control, and air flow stations as necessary.

C. Provide submittal data sheets, control drawings schematics (in Visio or AutoCAD), data entry, pneumatic (as required) and electrical installation, programming, start up, test and validation acceptance documentation, as-built documentation, maintenance manuals and system warranties.

D. All labor, material, equipment and services not specifically referred to in this specification or on associated drawings that are required to fulfill the functional intent of this specification shall be provided at no additional cost to the Owner.

E. The work covered by this specification and related sections consists of providing shop drawings, equipment, labor, materials, engineering, technical supervision, and transportation as required to furnish and install a fully operational BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:
   1. The preparation of submittals and provision of all related services.
   2. Furnish and install all to achieve system operation, any control devices, conduit and wiring, in the facility as required to provide the operation specified.
   3. Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
   4. Perform acceptance tests and commissioning as indicated.
   5. Provide full documentation for all applications and equipment.
   6. Miscellaneous work as indicated in these specifications.

1.9 WORK BY OTHERS

A. Setting in place of valves and dampers, access doors, flow meters, water pressure and differential taps, flow switches, thermal wells, fire and smoke control dampers, air flow stations, and current transformers shall be by others.

B. Duct smoke detectors shall be provided under Division xx yy zz. Connection of auxiliary terminals of duct smoke detectors shall be wired to the BAS for monitoring purposes only by this section.

C. High and low temperature thermostats shall be provided by this section.

D. Switches, and power wiring to motors, starters, thermal overload switches, and contactors, as specified. This Section includes the furnishing and installation of controls and wiring for automatic controls, electric damper and valve operators, terminal control units, interlocks, starting circuits, and wiring to power consuming control devices.

1.10 BAS CONTRACTOR QUALIFICATIONS

A. Within 14 days of award of the contract the BAS contractor is to:
   1. Provide proof of having a local office within 50 miles of project for at least 5 years, staffed by trained personnel capable of providing instruction, routine maintenance, emergency service on systems,

2. Provide record of successful installations of similar size, performed by Contractor submitting the tender, showing successful experience with similar computer based systems.
3. Provide proof of having access to local supplies of essential parts and provide 7 year guarantee of availability of compatible spare parts after manufacturer's declaration of obsolescence.
4. Provide proof of having in-house staff with expertise in pneumatic controls where applicable.
5. Provide Profiles for each employee who will be involved in this project.

1.11 SYSTEM DESIGN RESPONSIBILITY

A. Design and provide all conduit and wiring linking all elements of system, including future capability.

B. Design and provide all material for interfaces to existing pneumatic controls where applicable.

C. Location of controllers to be approved by Owner prior to installation.

D. Provide utility power or emergency power where directed and/or indicated on drawings, to controllers.

PART 2 - PRODUCTS

2.1 QUALITY ASSURANCE

A. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:2008 manufacturer, for a minimum duration of 5 years, at time of bid.

B. The Building Automation System shall be furnished, engineered, installed, tested and calibrated by factory certified technicians qualified for this work. The contractor shall be Factory Authorized in good standing with the Manufacturer. Factory trained technicians shall provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.
1. Upon request, installer shall present records of successful completion of factory training courses including course outlines.
2. Upon request, the installer shall provide a letter from the manufacturer that they are a Factory Authorized installer in good standing with the Manufacturer.

PART 3 - EXECUTION

3.1 COORDINATION

A. All work shall be performed at times acceptable to the Engineer/Construction Manager. Provide work schedule at the start of the job for the approval of the Engineer / Construction Manager. Schedule shall show when all staff and sub-contractors shall be on-site.

B. Organize all your sub-contractors and ensure that they maintain the schedule.

C. Full cooperation shall be shown with other sub-contractors to facilitate installations and to avoid delays in carrying out the work.

D. Notify Engineer/Construction Manager of any changes to the schedule. Send any schedule changes and weekly progress reports via e-mail to Engineer/Construction Manager.

E. Where, in the judgment of the Engineer/Construction Manager, the work could disrupt the normal operations in or around the building, contractor shall schedule work to eliminate or minimize interference.

F. When connecting to the existing systems, advise the Engineer/Construction Manager and obtain permission to so. Perform work at a time acceptable to the Engineer/Construction Manager and Owner.

3.2 SUPERVISION OF PERSONNEL

A. Maintain qualified personnel and supporting staff at this project with proven experience in erecting, supervising, testing, and adjusting projects of comparable nature and complexity.

B. Supervisory personnel and their qualifications are subject to the approval of the Owner.

C. All personnel working on-site shall sign in as required by the Owner and shall wear company identification.

D. When requested and for whatever reason, remove personnel and/or support staff from project. Take immediate action.

3.3 SYSTEM DESIGN AND RESPONSIBILITY

A. The drawings do not show conduit size or wire type to link the various elements of the system.

B. The BAS contractor is responsible for designing these links in view of the present and future capabilities.

C. The Contractor is responsible for supplying sufficient Controllers of all types to meet the intent of the specification.

D. The quantity and point content of the Controllers must be approved by the Engineer prior to point installation.

3.4 PRODUCTS

A. Materials and equipment shall be essentially the catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements.

B. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer, and the component parts of the system shall be the products of a single manufacturer.

C. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate securely attached in a conspicuous place.

3.5 ELECTRICAL WORK, WIRING AND SAFETY

A. Electrical work shall be in accordance ANSI/NFPA 70 and the local Electrical Code.

B. Based on project location, Regional Regulation Compliance Certifications (CSA C22.1) will be required.

C. Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.

D. All wiring shall conform to the most stringent requirements of the local electrical authority having jurisdiction. Refer to Division 26 00 00 for electrical requirements, codes and regulations.

E. All wiring associated with and required by the BAS shall be the responsibility of this contractor.
   1. The term "wiring" shall be construed to include furnishing of wire, conduit, and miscellaneous material and labor as required to install a total working system.
   2. If departures from the contract documents are deemed necessary by the contractor, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings to the Engineer for approval.

3.6 MANUFACTURER'S RECOMMENDATIONS

A. Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.7 NAMEPLATES

A. Nameplates shall be provided for all control items listed or shown in the submittal and approved control diagrams.

B. Each inscription shall identify its function, such as "mixed air controller", "cold deck sensor" in official languages etc. and when applicable, its position.
    1. Size of nameplates shall be 1 inch by 3 inches minimum.
    2. Lettering shall be minimum ¼ inch high normal black lettering.
    3. Submit duplicate samples of identification tags and lists of wording proposed for approval.

3.8 PRELIMINARY DESIGN REVIEW

A. The BAS contractor shall submit a preliminary design document for review. This document shall contain the following information:
    1. Provide a description of the proposed system along with a system architecture diagram with the intention of showing the contractors solution to meet this specification.
    2. Provide product data sheets and a technical description of all direct digital controller hardware required to meet specifications listed herein.
    3. Provide an overview of the BAS contractor's local/branch organization, local staff, recent related project experience with references, and local service capabilities.
    4. Provide information on the BAS contractor's project team including project organization, project manager, project engineer, programmers, project team resumes, and location of staff.
    5. Project Schedule of work indicating:
        a. Intended sequence of work items
        b. Start date of each work item
        c. Duration of each work item
        d. Planned delivery dates for ordered material and equipment and expected lead times
        e. Milestones indicating possible restraints on work by other trades or situations

3.9 SUBMITTALS

A. Within 45 days of award of contract and before start of construction, submit 3 hard copies and 1 soft copy of manufacturer's information and shop drawings.
    1. Drawings to be in AutoCAD or VISIO and Sequence of Operations and Points List (Input/output Summary) shall be in Word and Excel format (latest versions) structured using menu format for easy loading and retrieval on the OWS.

B. Provide in completely coordinated and indexed package to assure full compliance with the contract requirements.
    1. Piecemeal submittal of data is not acceptable and such submittals will be returned without review.
    2. Information shall be submitted for all material and equipment the contractor proposes to furnish under terms of this contract work.
    3. Arrange the submittals in the same sequence as these specifications and reference at the upper right-hand corner the particular specification provision for which each submittal is intended.

4. Submittals for each manufactured item shall be manufacturer's descriptive literature (equipment specification), equipment drawings, diagrams, performance and characteristic curves, and catalog cuts, and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size layout dimension, capacity, specification reference, applicable specification references, and all other information necessary to establish contract compliance.

C. Control System Shop Drawings
   1. Schematic diagram of each controlled system. Label control points with point names.
   2. Bill of Material for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
   3. Specification sheets for each item including manufacturers descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc.
   4. Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.
   5. Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.

3.10 AS-BUILT DOCUMENTATION (OPERATING AND MAINTENANCE (O&M) MANUALS)

A. As-built documentation shall consist of 4 hard copies and one soft copy for all information described below

B. The final documentation package shall include:
   1. Hard and soft copies of all control drawings.
   2. Manufacturer’s technical data sheets for all hardware and software.
   3. Factory operating and maintenance manuals with any customization required.
   4. Soft copies of programming and front-end software and each controller’s database. Hard copy output of programming is not necessary.
   5. Provide clear, concise, printed and soft copy descriptions of all control sequences in the working language.
   6. Soft copy text files shall be in Microsoft Word format.
   7. Copy of all graphics files.

C. Each instruction and reference manual shall be bound in hardback, 3 ring, binders or an approved equivalent shall be provided to the Engineer.
   1. Binders to be no more than 2/3 full.
   2. Each binder to contain index to full volume.

3. One complete set of manuals shall be furnished prior to the time that the system or equipment tests are performed, and the remaining manuals shall be furnished at acceptance.
4. The identification of each manual's contents shall be inscribed on the cover and spine.
5. The manuals shall include the names, addresses and telephone numbers of each subcontractor installing equipment systems and of the local representatives for each item of equipment and each system.
6. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject.
7. Additionally, each manual shall contain a comprehensive index of all manuals submitted in accordance with this paragraph.
8. Manuals and specifications shall be furnished which provide full and complete coverage of the following subjects:
    a. Operational Requirements: This document shall describe in concise terms, all the functional and operational requirements for the system and its functions that have been implemented. It shall be written using common terminology for building operation staff and shall not presume knowledge of digital computers, electronics or in-depth control theory.
    b. System Operation: Complete step by step procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats; and emergency, alarm and failure recovery. Step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
    c. Maintenance: Documentation of all maintenance procedures for all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective module. This shall include calibration, maintenance, and repair or replacement of all system hardware.
    d. Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures. A provision for the measurement or observation of results, based on the published test specification, forms the test reports. The procedures record and the results of these exercises shall be conveniently bound and documented together.
    e. Configuration Control: Documentation of the basic system design and configuration with provisions and procedures for planning, implementing, and recording any hardware or software modifications required during the installation, test, and operating lifetime of the system. This shall include all information required to ensure necessary coordination of hardware and software changes, data link or message format/content changes, and sensor or control changes in the event system modification are required, and to fully document such new system configurations.

3.11 MANUFACTURER TRAINING

A. Manufacturer provided training on the use and operation of all products provided within these specifications shall be available for purchase and attendance by the Owner or his designated agent.
   1. Such training shall be of the same curriculum as the training courses provided by the manufacturer to the Contractor.
   2. A manufacturer certified instructors shall give all training classes.
   3. A list of training courses with detailed course outline and duration with the associated cost shall be provided as part of the BAS submittals.

END OF SECTION 23 09 00

SECTION 23 09 13 - BAS INSTRUMENTATION AND CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. SECTION 23 09 00, BAS Instrumentation and Control

B. SECTION 23 09 13.13, BAS Actuators and Operators

C. SECTION 23 09 13.23, BAS Sensors and Transmitters

D. SECTION 23 09 13.43, BAS Control Dampers

E. SECTION 23 09 23, BAS Direct Digital Control System

1.2 REFERENCES

A. Refer to Section 23 09 00 - References

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 - PRODUCT

2.1 UNINTERRUPTABLE POWER SUPPLIES

A. Provide the OWS, Server, and each NCU with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to 15 minutes duration.

B. Acceptable Manufacturer is APC.

2.2 OPERATOR SOFTWARE

A. Operating System: See Sections 2.2 and 2.3 for specific OSs.

B. The software shall employ browser-like functionality for ease of navigation.
   1. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database.
   2. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills.
      a. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. An alternate Identification mechanism for advanced or simple query of the ECMS system.

D. Real-Time Displays.
    1. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
        a. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.
        b. The graphic shall provide for the ability to command each point, including both timed and permanent overrides.
        c. Provide for all information represented in the graphics in an associated graphical table with links to the equipment graphics and command-able points.
        d. Sample graphics shall be provided as part of the submittals for approval by owner.

E. The Operator software, shall at a minimum, support the following graphical features and functions:
    1. Graphic screens shall be developed using GIF, PNG, JPG or ICO file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
    2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, colour spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
    3. Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.

F. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
    1. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    2. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

G. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

H. Right-clicking the selected object and using a graphical slider to adjust the value shall make adjustments to analog objects, such as set points. No entry of text shall be required.

I. System Configuration.
    1. At a minimum, the Operator software shall permit the operator to perform the following tasks, with proper password access:
        a. Create, delete or modify control strategies.

b. Add/delete objects to the system.
c. Tune control loops through the adjustment of control loop parameters.
d. Enable or disable control strategies.
e. Generate hard copy records or control strategies on a printer.
f. Select points to be alarm-able and define the alarm state.
g. Select points to be trended over a period of time and initiate the recording of values automatically.

J. On-Line Help.
1. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.
a. On-line help shall be available for all applications and shall provide the relevant data for that particular screen.
b. Additional help information shall be available through the use of hypertext.
c. All system documentation and help files shall be in HTML format.

K. Security.
1. Each operator shall be required to log on to that system with a user name and password in order to view, edit add, or delete data.
2. System security shall be selectable for each operator.
3. The system administrator shall have the ability to set passwords and security levels for all other operators.
4. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
5. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
6. This auto log-off time shall be set per operator password.
7. All system security data shall be stored in an encrypted format.

L. System Diagnostics.
1. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
2. The failure of any device shall be annunciate to the operator.

M. Alarm Console.
1. The system shall be provided with a dedicated alarm window or console.
a. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
b. The use of the Alarm Console can be enabled or disabled by the system administrator.

i. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator.

c. This window will notify the operator of new alarms and un-acknowledged alarms.

d. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

N. Operator's software shall contain an easy-to-operate system; allowing configuration of system-wide controllers, including management and display of the controller programming.
   1. This system shall provide the capability to configure controller binary and analog inputs/outputs.

O. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.
   1. Graphics generation shall be done using standard Windows packages.
   2. No proprietary graphics generation software shall be needed.

P. Provide software, which enables the non-programmer operator to easily perform, tasks which are likely to be part of his daily routine.

Q. The operator's console shall provide facilities for manual entries and visual displays enabling an operator to enter information into the system and obtain displays and logs of system information.
   1. All requests for status, analog, graphic displays, logs, and control shall be selected from the operator's console.
   2. The operator interface shall minimize the use of typewriter style keyboard by implementing a mouse or similar pointing device and "point and click" approach to command selection.
   3. The facility shall be provided to permit the operator to perform the following tasks:
      a. Automatic logging of digital alarms and change of status message.
      b. Automatic logging of all analog alarms.
      c. System changes (alarm limits, set-points, alarm lock-outs, etc.).
      d. Display specific points as requested by the operator.
      e. Provide reports as requested by the operator and on Scheduled basis where so required.
      f. Display graphics as requested by the operator.
      g. Display of help information.
      h. Provide trend logs as required by the operator.
      i. Provide manual control of digital and analog outputs as required by the operator.
      j. Direct the hard copy output of information to the device selected by the operator.

k. Data displayed on monitor to cyclic update as appropriate.

R. Online changes:
1. Alarm limits.
2. Setpoints.
3. Dead-bands
4. Changes/deletions/additions of points.
5. Control and change of state changes.
6. Time of day, day, month, year.
7. Control loop control description changes for NCU based CDM's.
8. Control loop tuning changes
9. Schedule changes
10. Changes/additions/deletions to system graphics
11. Changes/additions/deletions to total systems

S. It shall be possible for the operator to override automatic analog and digital output commands.
1. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command.
2. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.
3. It shall be possible for the operator to place any computed system setpoint to a computed basis as and when required.
4. All above functions shall operate under the password protection system.

T. A vocabulary of at least 25 different descriptions using at least six alphanumeric characters to identify engineering units for analog input and output points. Typical description is as follows: %, ˚C, KPA, KW, KWH, L/S, CFM, ˚F, and PSI.
1. The descriptions shall be alterable from the OWS console with the system on-line.

U. Upon operator's request, the system shall present the condition of any single point, any system, and area or the whole system on printer or Monitor.
1. The output device shall be by operator's choice.
2. Analog values and status displayed on the Monitor shall be updated whenever new values are received.
3. Points in alarm shall be flagged by blinking, inverse video different colour, bracketed, or by some other means to differentiate them from points not in alarm.

V. Error Messages
1. Inform operator of all errors in data, errors in entry instructions, failure of equipment to respond to requests or commands, or failure of communications between components of BAS.
2. Error messages to be comprehensive and communicate clearly to operator precise nature of problem.

W. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on.
    a. Access shall be limited to operator's terminal functions unless user is logged on, including displays as outlined above.
2. Each operator's workstation shall provide security for 100 users minimum.
    a. Each user shall have an individual User ID, User Name and Password.
    b. Entries are alphanumeric characters only and are case sensitive (except for User ID).
    c. User ID shall be 8 characters,
    d. User Name shall be a maximum of 29 characters, and Password shall be a maximum of 8 characters long.
    e. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access.
    f. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal.
    g. Each user shall also have a set security level, which defines access to displays and individual objects the user may control.
    h. System shall include 10 separate and distinct security levels for assignment to users.

X. Trend Data

1. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.
    a. Archived files shall be appended with new sample data, allowing samples to be accumulated over **3** years.
    b. Systems that write over archived data shall not be allowed, unless limited file size is specified.
    c. Samples may be viewed at the operator's terminal in a trend log.
    d. Logged data shall be stored in spreadsheet format.
    e. Operator shall be able to scroll through all trend log data.
    f. System shall automatically open archive files as needed to display archived data when operator scrolls through the data vertically.
    g. All trend log information shall be displayed in standard engineering units.
2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colours and these Graphs shall show object type value relative to time.
3. Operator shall be able to change trend log setup information.
    a. This includes the information to be logged as well as the interval at which it is to be logged.
        i. Minimum interval of 1 minute.

b. All input, output, and value object types in the system may be logged.
c. All operations shall be password protected.
d. Setup and viewing may be accessed directly from any and all graphics object is displayed on.

4. System shall be capable of periodically gathering energy log data stored in the field equipment and archive the information on the operator workstation's hard disk.
   a. Archive files shall be appended with the new data, allowing data to be accumulated over several years.
   b. Systems that write over archived data shall not be allowed unless limited file size is specified.
   c. System shall automatically open archive files as needed to display archived data when operator scrolls through the data.
   d. Display all energy log information in standard engineering units.
5. System software shall be provided that is capable of graphing the energy log data. Software shall be capable of creating two-axis (x,y) graph that show recorded data, relative to time.
   a. All data shall be stored in spreadsheet format for direct use by third-party spreadsheet or other database programs.
   b. Operation of system shall not be affected by this operation.
6. Operator shall be able to change the energy log setup information.
   a. Including the meters to be logged, meter pulse value, and the type of energy units to be logged.
   b. All meters monitored by the system may be logged.
   c. All operations shall be password protected.

Y. Graphics
1. The operator's workstation shall display all data associated with the project.
   a. The operator's terminal software shall accept, GIF, PNG, JPG and ICO format graphic files for display purposes.
   b. Graphic files shall be created using scanned, full colour photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings.
   c. Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.
   d. Displays can be used as templates to produce other displays
2. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.
   a. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.
   b. All information on any display shall be dynamically updated without any action by the user.
   c. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.

d. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

3. All displays shall be generated and customized in such a manner by the local DDC system supplier that they fit the project as specified.
   a. Canned displays shall not be acceptable.
   b. Displays shall use Standard English for labelling and readout.
   c. Systems requiring factory programming for graphics are specifically prohibited.
   d. The installing contractor without factory dependency or assistance shall support all graphics and DDC programming locally.
4. Binary objects shall be displayed as ON/OFF/NULL or with customized text.
   a. Text shall be justified left, right or centre as selected by the user.
   b. Allow binary objects to be displayed as individual change- of-state bitmap objects on the display screen such that they overlay the system graphic.
   c. Each binary object displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm.
   d. For binary outputs, toggle the objects commanded status when the bitmap is selected with the system digitizer (mouse). Similarly, allow the terminal operator to toggle the object's status by selecting (with the mouse) a picture of a switch or light, for example, which then displays a different picture (such as an ON switch or lighted lamp).
   e. Additionally, allow binary objects to be displayed as an animated graphic.
5. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
   a. For example: when a pump is in the OFF condition, display a stationary picture of the pump. When the operator selects the pump picture with the mouse, the represented objects status is toggled and the picture of the pumps impeller rotates in a time-based animation.
   b. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF.
   c. Allow operator to change bitmap file assignment and also create new and original bitmaps online.
   d. System shall be supplied with a library of standard bitmaps, which may be used unaltered or modified by the operator.
   e. Systems that do not allow customisation or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.
6. Analog objects shall be displayed with operator modifiable units.
   a. Analog input objects may also be displayed as individual bitmap items on the display screen as an overlay to the system graphic.

b. Each analog input object may be assigned to a minimum of five bitmap files, each with high/low limits for automatic selection and display of the bitmaps.
c. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint.
d. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box.
e. Selection for display type shall be individual for each object.
f. Analog object values may be changed by selecting either the increase or decrease arrow in the analog object spinner box without using the keypad.

7. Analog objects may also be assigned to an area of a system graphic, where the colour of the defined area would change based on the analog objects value.
   a. For example, an area of a floor-plan graphic served by a single control zone would change colour with respect to the temperature of the zone or its deviation from setpoint.
   b. All editing and area assignment shall be created or modified online using simple icon tools.
8. A customized menu label (push-button) shall be used for display selection.
   a. Menu items on a display shall allow penetration to lower level displays or additional menus.
   b. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item.
   c. Each display may be protected from viewing unless operator has appropriate security level.
   d. A separate security level may be assigned to each display and system object.
9. A mouse, or other form of digitizer, shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.
10. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
    a. The presentation will contain displays for:
       i. Site Overview
       ii. Specific Building(s)
       iii. Floor plates within Building(s)
       iv. Each controlled Zone
       v. Each controlled System or Sub-System
    b. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
       i. Clicking on a building in the Site Overview displays the specific building display.
       ii. Clicking on a floor, displays the floor plate display
       iii. Clicking on a zone, displays the specific control system for that zone.

iv. Clicking on a specific system or sub-system coarse representation at the floor plate display level displays a detailed presentation of the system or sub-system.

11. Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.

Z. Alarms

1. Operator's terminal shall provide audible, visual, electronic and printed means of alarm indication.
2. Any alarm may be handled based on its individual or assigned class actions.
   a. Actions are, but not limited to
      i. Displayed on the Alarm console.
         a) The system shall be provided with a dedicated alarm window or console.
         b) This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
         c) The use of the Alarm Console can be enabled or disabled by the system administrator.
         d) When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator.
         e) This window will notify the operator of new alarms and un-acknowledged alarms.
         f) Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
         g) Printout of alarms shall be sent to the assigned terminal and port.
      ii. Delivery by electronic mail (e-mail).
         a) Sent via e-mail to one or more recipients.
      iii. Printed.
         a) Printed on local or network printer
3. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.
   a. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.
4. Alarm messages shall be in user-definable text English or other specified language) and shall be entered either at the operator's terminal or via remote communication.

AA. Scheduling

1. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
   a. This includes all ON/OFF times (to the minute) for each day's events.

2. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
    a. These speciality schedules shall be displayed at the operator's terminal in a format similar to the weekly schedules, again allowing easy data entry.
    b. Exception schedule data is entered by the following methods:
        i. date entries (one day entries)
        ii. date-to-date (a range or span of days)
        iii. by weekday (for example, a given day of a given week each month)
    c. User shall be able to scroll easily through the months for each year as a minimum.
3. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

BB. Archiving
1. Store back-up copies of all controller databases in at least one OWS and the server.
2. Provide continuous supervision of integrity of all controller databases.
    a. Data base back up and downloading to occur over LAN without operator intervention.
3. Operator to be able to manually download entire controller database or parts thereof.

CC. Reports
1. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
    a. If display output (Monitor) is requested, it shall be scrollable; scroll bars will be used to allow easy and flexible movement within the report.
    b. Output to be sorted by area, system point.
2. Periodic/Automatic Report:
    a. Provide the software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
    b. The software will allow the operator to modify the periodic/automatic reporting profile at any time.
3. As a minimum, the following reports shall be configured on the system:
    a. Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency and it shall be possible to select points on the following basis:
        i. All points in all areas

ii. Area (all points in area)
iii. Area system (all points in system)
iv. Area system point (individual point)
v. System (all points by system and point type)
vi. System point (all points by system and point type)
vii. Area point (all points by area and point type).

b. Summary Report:
i. To permit the display or printing of the dynamic values for the user specified points.
a) Reports to be available on same basis as dynamic reports.
b) Output will be to the user selected output device.

c. Trend Reports:
i. To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.

d. Historical Data Collection:
i. Provision shall be made to ensure historical data is not lost.
a) The ability to off-load historical data to removable media, and to later load data previously backed-up, will be provided.
b) Historical data values, for an operator specified time range and for operator specified points, may be output the same as for trend data.

e. Critical Alarm Summary:
i. Provide a summary of those points in the critical alarm state and include as a minimum; point acronym, point description, alarm type, limit exceed, current value, alarm type, time and date of occurrence.

f. Maintenance Alarm Summary:
i. Provide a summary of those points in maintenance alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceed, time and date of occurrence.

g. Alarm Summary:
i. Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.

h. Disable Point Summary:
i. Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.

i. Run Time Summary:
i. Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.

j. Schedule Summary:

i. Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.

k. User Record Summary:

i. Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.

DD. LCU / TCU Programming Software

1. The Programming software must be able to be seamlessly launched from within the Niagara Framework as a wizard.
   a. Connection methods (Tunneling or by building controller – not direct to controller).
2. Provide programming software for the Local Control Unit (LCU) and the Terminal Control Unit (TCU) that allows for the development of the LCU/TCU control logic and point management and Graphical User Interface screens.
   a. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens.
   b. Access to these functions shall be provided through Graphical User Interface software (GUI).
   c. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool.
   d. Completed applications may be stored in the library for future use.
   e. Graphical User Interface screens shall be created in the same fashion.
   f. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates.
   g. Any real-time data value or object property may be connected to display its current value on a user display.
   h. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
   i. Programming Methods:
      i. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application.
      ii. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another.
      iii. Object links will support one-to-one, many-to-one, or one-to-many relationships.

iv. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.

j. Object Configuration

i. Each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons.

ii. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

k. The software shall provide the ability to view the logic with values being inputted to and outputted from the graphical blocks in real time. (debug mode)

l. The system shall support object duplication within a client's database.

i. An application, once configured, can be copied and pasted for easy re-use and duplication.

ii. All links, other than to the hardware, shall be maintained during duplication.

m. Provides function to compare and calculate from multiple values from networked controllers (NCU, TCU and/or LCU).

n. As a minimum, the function shall calculate and compared the values and return the average, sum, highest, lowest, 3 highest, 3 lowest values and multi-state value count.

o. Auto-linking of objects to graphics

p. Auto-Encapsulate functionality (the automatic ability to group multiple programming objects into a new singular programming object).

q. Allow for uploading/downloading to/from multiple controllers

EE. Utility Software

1. Supply and install software products to allow the owner to access and manipulate the control schematic diagrams, and to access product data sheets in an electronic format.
2. Enter all soft copy submissions; including "Record" drawings as specified herein [Shop Drawings, Product Data and Review Process] in OWS.

2.3 NATIVE WEB BROWSER INTERFACE

A. The contractor shall provide web-browser delivered graphical visualization software as part of the operator workstation, server, NAC(s), and/or IP-CTRL devices, as indicated on construction documents. The contractor shall configure the graphical visualization software in accordance with project requirements.

B. The graphical visualization software shall have two operating modes: Studio & Viewer, as described below. For both Studio & Viewer modes, the graphical user interface shall be delivered to the user by pointing a modern web browser to a project-specific URL and logging into the system. The software shall not require any software plugins to be installed in conjunction with the web browser.

C. When delivered to a modern web browser, the software shall implement web development standards, including but not limited to Hypertext Markup Language (HTML) v5, Cascading Style Sheets (CSS) v3, and JavaScript (in compliance with ECMAScript specifications).

D. Studio Mode:
   1. The graphical visualization software shall allow upload of user-generated content such as logos or floorplan background images.
   2. The graphical visualization software shall allow assembly and configuration of repeatable design elements, such as a table row for a points list, or an informative callout for equipment on a floor plan.
   3. The graphical visualization software shall allow for use of dynamic, zoomable, extensible mapping interfaces, such as Google Maps, provided internet connectivity.
   4. The graphical visualization software shall support creation and configuration of multiple chart types, including but not limited to line charts, bar charts, area charts, pie charts, including use of multiple foreground and background colors, legend positioning and color gradients.
   5. The graphic visualization software shall allow both view and manipulation (subject to user access level) of real-time data present on the host, as well as historical trend data. The scope of data shall depend only on whether the host device is an operator workstation, server, NAC, or IP-CTRL device and has been fully configured to meet project-required sequence of operation.
   6. The graphic visualization software shall allow binding of any data and/or data manipulation method to applicable graphical design elements, including but not limited to: text labels, buttons, charts, geographical mapping interfaces, applied against applicable properties including but not limited to: position/size, background image/color, foreground color, foreground font properties, visibility, opacity, animation timing and rotation.
   7. The graphic visualization software shall allow manipulation of position/scaling properties of any and all visual elements, with respect to user's screen size, parent and nested visual elements, and/or "User Agent Type" (designating Web Browser vendor and version), such that graphical screens created may be delivered and perform equally well on laptop screens, large displays, and/or mobile devices.

E. Viewer Mode:
   1. In viewer mode, the graphical visualization software shall deliver content to the user's web browser in a fashion that matches configuration accomplished in Studio Mode.

2. Scope and amount of content delivered in Viewer mode, and access to data manipulation methods shall be determined by which user has authenticated.

2.4 BAS CONTROLLERS

A. Controllers –BACnet/IP Protocol
   1. Provide BACnet Controllers that are BACnet Testing Laboratory listed (v12 or later) as specified herein:
      a. BACnet Building Controller (B-BC)
      b. BACnet Advanced Application Controller (B-AAC)
      c. BACnet Application Specific Controller (B-ASC)
   2. All BACnet/IP Controllers shall use the following communication specifications and achieve performance as specified herein:
      d. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (NCU).
         i. Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
      e. Performance
         ii. Each BACnet controller shall have a minimum of 512KB of RAM and 4GB of non-volatile flash memory.
         iii. Each controller shall have a 32-bit microprocessor operating at 600 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
      f. BACnet Controllers shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings.
         iv. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
      g. Control Unit (LCU) and Terminal Control Unit (TCU)
         v. Shall be fully programmable and the programming software shall have a library of pre-built, tested, and user re-definable control sequences for a wide range of typical HVAC applications.
         vi. All control sequences programmed into the LCU and TCU shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
         vii. LCU and TCU controllers that are not fully programmable and/or cannot retain programming as outlined in .2 are not acceptable.
      h. BACnet Controllers shall communicate with the Network Control Unit (NCU) via a BACnet/IP connection at a baud rate of not less than 100 Mbps

i. BACnet TCU to have a communications port for connecting a matching room temperature and/or humidity sensor and does not utilize any of the I/O points of the Controller.

viii. The TCU and all other devices on the BACnet bus shall be accessible from this communications port.

j. The Contractor supplying the BACnet Controllers shall provide documentation for each device, with the following information at a minimum:

ix. BACnet Device; MAC address, name, type and instance number.

x. BACnet Objects; name, type and instance number

k. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each BACnet controller, as required by the Point List located in the POINTS LIST section of this specification.

B. Controllers – BACnet Protocol

1. Provide BACnet Controllers that BACnet Testing Laboratory listed (v12 or later) as specified herein:
   a. BACnet Building Controller (B-BC)
   b. BACnet Advanced Application Controller (B-AAC)
   c. BACnet Application Specific Controller (B-ASC)
2. All BACnet Controllers shall use the following communication specifications and achieve performance as specified herein:
   a. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (NCU).
      i. Any controller on the MS/TP Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
   b. Performance
      i. Each BACnet MS/TP controller shall have a minimum of 64Kb of RAM and 384Kb of non-volatile flash memory.
      ii. Each controller shall have a 32-bit microprocessor operating at 68 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
      iii. Each BACnet controller on the BACnet MS/TP communications trunk shall provide a loading characteristic of minimum 1/8th Load.
      iv. Manufacturers, who wish to supply LCU and TCU controllers with less than a 32-bit microprocessor and/or a MS/TP loading characteristic of greater than 1/8th Load, may do so as long as they only provide a maximum of 32 controllers on a single bus segment per NCU.
   c. BACnet Controllers shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings.

i. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

d. Control Unit (LCU) and Terminal Control Unit (TCU)

i. Shall be fully programmable and the programming software shall have a library of pre-built, tested, and user re-definable control sequences for a wide range of typical HVAC applications.

ii. All control sequences programmed into the LCU and TCU shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

iii. LCU and TCU controllers that are not fully programmable and/or cannot retain programming as outlined in .2 are not acceptable.

e. BACnet Controllers shall communicate with the Network Control Unit (NCU) via a BACnet/IP connection at a baud rate of not less than 100 Mbps or via the RS485 MS/TP connection at a baud rate of not less than 76.8 kbps.

f. BACnet TCU to have a communications port for connecting a matching room temperature and/or humidity sensor and does not utilize any of the I/O points of the Controller.

i. The TCU and all other devices on the BACnet bus shall be accessible from this communications port.

g. The Contractor supplying the BACnet Controllers shall provide documentation for each device, with the following information at a minimum:

i. BACnet Device; MAC address, name, type and instance number

ii. BACnet Objects; name, type and instance number

h. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each BACnet controller, as required by the Point List located in the POINTS LIST section of this specification.

i. Network configuration parameters (nci, nco); name and type

ii. Configuration Properties (CP's): name and type

C. Local Control Units (LCU) (Primary Systems such as AHU, MAU, Chiller, Boiler, Water System)

1. The Local Control Units (LCU) shall be 32 bit microprocessor-based.

a. They shall also be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.

b. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

c. The LCU factory installed integral color operator interface (see 23 09 13 **Error! Reference source not found.** for details) that provides real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.

i. Alternatively a field mounted display and interface, meeting the specified functionality, shall be supplied for each controller in lieu of this requirement.

2. Each LCU shall have sufficient memory, to support its own operating system and databases, including:
   a. Control processes
   b. Energy management applications
   c. Alarm management applications
   d. Historical/trend data for points specified
   e. Maintenance support applications
   f. Custom processes
   g. Manual override monitoring
3. Each LCU shall support:
   a. Monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:
      i. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
      ii. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
      iii. Each LCU shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:
      iv. Digital outputs (contact closure for motor starters up to size 4).
      v. Analog outputs of 4-20 mA and 0-10 Vdc.
4. The LCU analog or universal input shall use a 16 bit A/D converter.
   a. Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
5. The LCU analog or universal output shall use a 10 bit D/A converter.
6. Each LCU shall have a minimum of 10% spare capacity for each point type for future point connection.
   a. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
   b. As a minimum, provide one of each type of point available on the controller.
7. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
      i. A turn and select navigation jog dial to access, edit, and modify internal controller functions. The jog dial shall be used to navigate through menus, select options and icons, and change parameters. Scroll buttons (up, down, left and right) shall not be acceptable.
      ii. Navigable menus to display, select, edit, and modify values and other controller information.
      iii. List-based menus with a minimum of eight (8) lines of text.
      iv. Icon-based menus.

v. A display with the following minimum characteristics: a resolution of 400 W x 240 H pixels with an effective viewing area of 2.4" L x 1.4" H, and 2.8" diagonal viewing area.

b. The operator interface shall use color-codes with icons and text lists to indicate values and controller statuses.

c. The operator interface shall, at a minimum, have the following functions:

i. Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, multistate values, Intelligent Space Sensor (ISS) (see section 23 09 132.11IntelligentSpaceSensors(ISS)) inputs, and wireless inputs.

a) The points list menus shall allow the operator to monitor, set, and override controller points and values.

b) A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.

ii. Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.

a) The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.

b) The combination of an icon and its color state shall notify the operator of an alarm condition.

c) The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.

iii. Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.

iv. PID loops. The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).

v. The operator interface shall support Latin-based languages and allow the interface user to select from three (3) defined languages.

vi. The operator interface shall allow personalization of a contact information screen with a minimum of eight (8) lines of user configurable text as well as the option to add a color graphic such as a company logo. The tool shall support, but not be limited to; image file formats such as GIF, PNG, JPG, etc.

vii. Favorites. The operator interface shall allow access to a list of bookmarked points.

viii. Weather. The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.

ix. Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. A password icon shall indicate the lock mode state.

x. Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.

8. The LCU shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components.
   a. The controller shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication.
9. Should the LCU memory be lost for any reason, the user shall have the capability of reloading the controller software via the BAS LAN OWS or Server.
   a. Controller requiring a local port to reload the controller software is not acceptable.
10. Provide an onboard network communication jack for connection to the BACnet Network (RJ-45 or equivalent quick connect)
11. Wireless port supporting a wireless transceiver for communication with wireless sensors/switches
12. Acceptable Products:
    a. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) or BACnet Advanced Application Controller (B-AAC)
    b. LonMark certified with the appropriate Functional Profile to their application so long as an appropriate LonMark Functional Profile exists.

D. IP Plant Controller (IP-SYS-CTRL)
   1. The IP-SYS-CTRL shall be 32 bit microprocessor-based operating at a minimum of 1 GHz.

a. They shall be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.
b. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

2. Each IP-SYS-CTRL shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases, including:
   a. Control processes
   b. Energy management applications
   c. Alarm management applications
   d. Historical/trend data for points specified
   e. Maintenance support applications
   f. Custom processes
   g. Web Based interface via integral Web Server.
   h. Support for up to a minimum of 256 I/O points which are added via Expansion I/O modules.
   i. Shall have a graphical interface with a common library of HVAC system image and animation such as AHU, MAU, Boiler Plant, Chiller Plant, and Rooftop Unit.
3. The IP-SYS-CTRL shall have a Real Time clock.
4. The IP-SYS-CTRL will support the following communications protocols:
   a. BACnet/IP
      i. Supporting IPv4 addressing.
      ii. DHCP support and Auto DNS.
      iii. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
         a) Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
      iv. If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
   b. BACnet MS/TP supporting up to minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
      i. Supporting 9600 to 115200 baud
   c. Modbus RTU
      i. Supporting 9600 to 115200 baud
   d. Modbus TCP
   e. 2 x USB 2.0 Expansion ports for:
      i. 802.11 Wi-Fi Adapter enabling wireless connectivity including:
         a) 'Hot Spot'
         b) Client
         c) Access Point
      ii. If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality.
5. Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module
6. Acceptable Products:

a. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.

E. IP-SYS-CTRL Communication Modules
1. Each IP-SYS-CTRL Communication module shall be capable of RS-485 communication with the following requirements, without the additional gateways/routers to enable RS-485 communication:
2. Include two separate RS-485 communication ports.
   a. Allow for either Modbus RTU or BACnet MS/TP communication on either of the ports
3. Allow for a minimum of 32 Modbus RTU communicating devices and/or a minimum of 50 BACnet MS/TP communicating devices to be connected on each RS-485 segment.

F. IP-SYS-CTRL Expansion I/O modules:
1. Each IP-SYS-CTRL Expansion I/O module shall be capable of monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:
   a. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
   b. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
      i. The analog or universal input shall use a 16 bit A/D converter.
         a) Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
2. Each IP-SYS-CTRL Expansion I/O module shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:
   a. Digital outputs.
      i. Optional Form C relay outputs.
      ii. Optional Triac Outputs.
   b. Analog outputs of 4-20 mA and 0-10 Vdc.
      i. The analog or universal output shall use a 10 bit D/A converter.
   c. HOA (Hand, Off, Auto) support.
3. Each completed configuration of IP-SYS-CTRL and Expansion I/O modules shall have a minimum of 10% spare capacity for each point type for future point connection.
   a. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
   b. As a minimum, provide one of each type of point available on the controller.
4. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.

G. IP Equipment Controller (IP-EQUIP-CTRL)

1. The IP-EQUIP-CTRL shall be 32 bit microprocessor-based operating at a minimum of 600 MHz.
    a. They shall be multi-tasking, real-time digital control processor based supporting a fixed I/O point count.
2. Each IP-EQUIP-CTRL shall have minimum of 512MB memory, with a minimum of 4 GB non-volatile flash, to support its own operating system and databases, including:
    a. Control processes
    b. Maintenance support applications
    c. Custom processes
    d. Energy management applications
    e. Alarm management applications
    f. Historical/trend data for points specified
    g. Embedded Web Server for local hosting of graphics
3. The IP-EQUIP-CTRL shall have a Real Time clock with rechargeable battery.
4. Power Requirements
    a. 24 VAC with local transformer power
5. The IP-EQUIP-CTRL will support the following communications protocols:
    a. BACnet/IP
        i. Supporting IPv4 addressing.
        ii. DHCP support and Auto DNS.
        iii. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
            a) Supporting controller daisy-chain topology on the wired IP network via integrated switch functionality.
            b) Integrated fail-safe should allow for communication when the controller is powered down.
        iv. If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
    b. 2 x USB 2.0 Expansion ports for:
        i. 802.11 Wi-Fi Adapter enabling wireless connectivity including:
            a) 'Hot Spot'
            b) Client
            c) Access Point
        ii. If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality.
6. The IP-EQUIP-CTRL controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC (±15%), allowing for power source fluctuations and voltage drops.
7. The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.
8. The controllers shall also function normally under ambient conditions of -40 ˚F to 158 ˚F and 0% to 90% RH (non-condensing).
9. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

10. Provide a minimum of 8 software configurable Universal Inputs capable of supporting the following input signal types:
    a. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
    b. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
    c. The analog or universal input shall use a 16 bit A/D converter.
        i. Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
11. Provide a minimum of 2 software configurable Universal Outputs capable of supporting the following output signal types:
    a. Digital outputs.
    b. Analog outputs of 4-20 mA and 0-10 Vdc.
        i. The analog or universal output shall use a 10 bit D/A converter.
12. Provide a minimum of 4 digital/Triac outputs.
13. Provide a minimum of 2 software configurable outputs that can either be utilized as additional digital/Triac outputs or as universal outputs.
14. Provide a minimum of 3 Modbus connected devices.
    a. Provide (optional) on-board RS-485 communication for Modbus RTU communication to a minimum of 3 connected devices on the RS-485 segment.
    b. Provide (optional) Modbus TCP communication to a minimum of 3 connected devices.
15. Provide connection to Intelligent Space Sensors (ISS) (see section 23 09 132.13 Intelligent Space Sensors (ISS)) via on-board RJ-45 subnetwork port.
16. Shall contain a “FIPS 140-2 Level 1 Compliant” cryptographic module

H. IP Terminal Unit Controller (IP-TU-CTRL) .
    1. The IP-TU-CTRL shall be 32 bit microprocessor-based operating at a minimum of 600 MHz. .
        .1 They shall be multi-tasking, real-time digital control processor based supporting a fixed I/O point count.
    2. Each IP-TU-CTRL shall have minimum of 512MB memory, with a minimum of 4 GB non-volatile flash, to support its own operating system and databases, including: .
        .1 Control processes
        .2 Maintenance support applications
        .3 Custom processes
        .4 Energy management applications
        .5 Alarm management applications
        .6 Historical/trend data for points specified
        .7 Embedded Web Server for local hosting of graphics.
    3. The IP-TU-CTRL shall have a Real Time clock with rechargeable battery.
    4. Power Requirements.
        l. 24 VAC with local transformer power.
    5. The IP-TU-CTRL will support the following communications protocols: .
        m. BACnet/IP.
            i. Supporting IPv4 addressing.

ii. DHCP support and Auto DNS.
iii. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
a) Supporting controller daisy-chain topology on the wired IP network via integrated switch functionality.
b) Integrated fail-safe should allow for communication when the controller is powered down.
c) If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.

n. 2 x USB 2.0 Expansion ports for:
iv. 802.11 Wi-Fi Adapter enabling wireless connectivity including: .
a) 'Hot Spot'.
b) Client
c) Access Point.
v. If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality..

6. The IP-TU-CTRL controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC (±15%), allowing for power source fluctuations and voltage drops.
7. The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.
8. The controllers shall also function normally under ambient conditions of -40 ˚F to 158 ˚F and 0% to 90% RH (non-condensing).
9. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
10. Provide a minimum of 8 software configurable Universal Inputs capable of supporting the following input signal types:
o. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
p. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
i. The analog or universal input shall use a 16 bit A/D converter.
ii. Controllers with less than 16 bit A/D converters must provide all analog input sensors with 4-20ma transmitters.
11. Provide a minimum of 2 software configurable Universal Outputs capable of supporting the following output signal types:
q. Digital outputs.
r. Analog outputs of 4-20 mA and 0-10 Vdc.
i. The analog or universal output shall use a 10 bit D/A converter.
12. Provide a minimum of 4 digital/Triac outputs.
13. Provide a minimum of 2 software configurable outputs that can either be utilized as additional digital/Triac outputs or as universal outputs.
14. Provide connection to Intelligent Space Sensors (ISS) (see section 25 30 012.5IntelligentSpaceSensors(ISS)) via on-board RJ-45 subnetwork port.
15. Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module

I. IP VAV Controller (IP-VAV)
   1. Refer to 25 30 01 Variable Air Volume (VAV) Terminal Control Units (TCU) for VAV related functionality requirements.
      a. In cases of conflict between this section (IP-VAV) and the referenced section (VAV) this section (IP-VAV) takes precedence.
   2. The IP-VAV-CTRL shall be 32 bit microprocessor-based operating at a minimum of 400 MHz.
   3. They shall be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.
   4. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
   5. Each IP-VAV-CTRL shall have minimum of 512MB memory, with a minimum of 1GB non-volatile flash, to support its own operating system and databases, including:
      a. Control processes
      b. Maintenance support applications
      c. Custom processes
   6. The IP-VAV-CTRL shall have a Real Time clock with rechargeable battery.
   7. Power Requirements
      a. 24 VAC with local transformer power
      b. 50 VAC utilizing Power Over Ethernet (POE)
   8. The IP-VAV-CTRL will support the following communications protocols:
      a. BACnet/IP
         i. Supporting IPv4 addressing.
         ii. DHCP support and Auto DNS.
         iii. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
         iv. If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
      b. 2 x USB 2.0 Expansion ports for:
         i. 802.11 Wi-Fi Adapter enabling wireless connectivity including:
            a) 'Hot Spot'
            b) Client
            c) Access Point
         ii. If the above functionality is not available then appropriate wireless router(s) and switches must be supplied to provide the functionality.
   9. Shall contain a "FIPS 140-2 Level 1 Compliant" cryptographic module
   10. Acceptable Products:
      a. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC)

J. Variable Air Volume (VAV) Terminal Control Units (TCU)
   1. The VAV TCU controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC (±15%), allowing for power source fluctuations and voltage drops.

2. The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.
3. The controllers shall also function normally under ambient conditions of -40 ˚F to 158 ˚F and 0% to 90% RH (non-condensing).
4. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
5. The VAV TCU shall include a built-in 'flow thru' differential pressure transducer.
    a. The controller shall convert this value to actual air flow.
    b. Single point differential pressure sensing device is not acceptable.
    c. Membrane based pressure differential transducer is not acceptable.
    d. The VAV TCU differential pressure transducer shall have a measurement range of 0 to 2 in. W.C. and measurement accuracy of ±4% at 0.05 to 2 in. W.C. and a minimum resolution of 0.0001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters.
    e. VAV TCU differential pressure transducer requiring periodic zero value air flow calibration is not acceptable.
6. The BAS contractor shall verify the type of differential pressure sensors used in the existing boxes, and ensure compatibility with the VAV TCU controllers.
7. The VAV TCU shall include provision for air flow balancing using a local air flow balancing interface.
8. An Intelligent Space Sensor (ISS) (see section 23 09 132.11IntelligentSpaceSensors(ISS)) shall be used for balancing air flow.
    a. In lieu of an ISS, a portable air flow balancing interface capable of balancing air flow is acceptable.
9. The portable air flow balancing interface shall connect to the VAV TCU or the matching room temperature sensor.
10. The VAV TCU shall also provide an air flow balancing tool.
11. This tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
12. Systems not able to provide a web based air balance tool or a portable air flow balancing interface or an Intelligent Space Sensor (ISS) (see section 23 09 132.11IntelligentSpaceSensors(ISS)) capable of balancing air flow as part of the VAV TCU controller shall provide an individual full time technician during the air flow balancing process to assure full balance compliance.
13. The VAV box controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature to within ±1.5 ˚F of setpoint at the room sensor location.
14. Each controller shall also incorporate an algorithm that allows for resetting of the associated air handling unit discharge temperature if required to satisfy space requirements.

a. This algorithm shall function to signal the respective controller to perform the required discharge temperature reset in order to maintain space temperature setpoint.

15. It shall be possible to view and reset the space temperature, temperature setpoint, maximum airflow setting, minimum airflow setting, and actual airflow, through the BAS LAN.

2.5 MOBILE APPLICATION FOR ANDROID[1] AND IOS®[2] PLATFORMS

A. The application for mobile platforms shall provide real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
   1. The operator interface consists of :
      a. An icon-based, interactive application for Android and iOS devices.
      b. Standard Android and iOS navigation methods shall be used to access, edit, and modify internal controller functions and shall be used to navigate through menus, select options and icons, and change parameters.
      c. Navigable menus to display, select, edit, and modify values and other controller information.
      d. List-based menus.
      e. Icon-based menus.
   2. The operator interface shall use color-codes with icons and text lists to indicate values and controller statuses.
   3. The operator interface shall, at a minimum, have the following functions:
      a. Points. The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, multistate values, Intelligent Space Sensor (ISS) (see section 23 09 132.11IntelligentSpaceSensors(ISS)) inputs, and wireless inputs.
         i. The points lists menus shall allow the operator to monitor, set, and override controller points and values.
         ii. A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.
      b. Alarms. The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
         i. The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
         ii. The combination of an icon and its color state shall notify the operator of an alarm condition.
         iii. The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.

[1] An open source operating system by Google, based on the Linux kernel.

[2] Is a mobile operating system developed by, and a registered mark of, Apple Inc.

c. Overrides. The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
d. PID loops. The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).
e. The operator interface shall support Latin-based languages and allow the interface user to select from three (3) defined languages.
f. The operator interface shall allow personalization of a contact information screen with a minimum of eight (8) lines of user configurable text as well as the option to add a color graphic such as a company logo. The tool shall support, but not be limited to; image file formats such as GIF, PNG, JPG, etc.
g. Favorites. The operator interface shall allow access to a list of bookmarked points.
h. Weather. The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.
i. Password protected. The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user-defined log-off delay. A password icon shall indicate the lock mode state.
j. Settings. The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.

2.6 INTELLIGENT SPACE SENSORS (ISS)

A. Intelligent Space Sensors (ISS) shall communicate on a daisy-chained network connected to any Local Control Unit (LCU) or Terminal Control Unit (TCU) and shall provide ambient space condition sensing without the use of hardware I/O at the LCU or TCU.

B. Each ISS shall provide a white Liquid Crystal Display (LCD), where indicated on the drawings, with the following minimum features:
   1. Minimum 1.4" x 1.18" display area
   2. Backlit

C. The ISS shall be capable of displaying on its LCD the measured space temperature from 50 ˚F to 104 ˚F and/or humidity from 0 % RH to 100 % RH with one decimal and/or the CO2 measurement from 0 to 2000 ppm.

D. The ISS with motion sensor shall have a motion indicator LED that provides a visual confirmation whenever motion is detected. A feature used to enable or disable this motion indicator shall be provided.

E. The ISS shall be capable of displaying the following elements:
   1. Space temperature
   2. Cooling space temperature set point
   3. Heating space temperature set point
   4. Current heating or cooling mode
   5. Current occupancy mode
   6. Fan speed
   7. Light status
   8. Blind position
   9. Alarm condition
   10. Current time
   11. Energy consumption indicator

F. Each ISS shall provide a local keypad for local user interface to perform navigation and adjustment of points configured as adjustable.

G. The ISS shall be configured for the LCU or TCU intended application requirements.

H. Provide an ISS where indicated on the drawings each ISS shall provide at a minimum the following on-board integral I/O without the consumption of any inputs and/or outputs at the host LCU or TCU:
   1. Temperature Sensor
      a. Sensing Element: 10k Thermistor
      b. Accuracy: ±0.9 ˚F
      c. Resolution: ±0.18 ˚F
      d. Range: 41 ˚F to 104 ˚F
   2. Relative Humidity Sensor
      a. Accuracy: ±3 % RH
      b. Resolution: 1 % RH
      c. Range: 10 % RH to 90 % RH
   3. CO2 Sensor
      a. Accuracy: 400 to 1,250 ppm ± 30 ppm or 3% of reading, 1,250 to 2,000 ppm ± 5% of reading + 30 ppm
      b. Range: 0 to 2,000 ppm
      c. Operating elevation: 0 to 16,000 ft
      d. Calibration method: self-calibration method eliminates the need for manual calibration and calibrates the sensor based on baseline concentrations measured during unoccupied periods in the space. Sensor shall not require manual calibration over a minimum product rated life of 15 years.
      e. Temperature dependence: 0.11% FS per ˚F
      f. Stability: <2% of FS over life of sensor (15 years)
      g. Pressure dependence:0.135% of reading per mm Hg
      h. Sensing method: Non-dispersive infrared (NDIR) absorption and Gold plated optics shall be provided.

4. Motion Sensor
    a. Type: Passive Infrared (PIR) sensor with Fresnel lens
    b. Vertical detection range: up to 20 ft. x 30 degree detection angle
    c. Horizontal detection range: up to 20 ft. x 120 degree detection angle

I. The ISS shall provide function to fully balance the air flow of a Variable Air Volume (VAV) Terminal Control Unit (TCU).
    1. The ISS shall allow the air balancer to control the action of the VAV TCU including the following function: open VAV damper, close VAV damper, go to flow setpoint.
    2. The ISS shall allow the air balancer to enter flow related parameters including minimum air flow, maximum air flow and K factor.
    3. The ISS shall be capable of operating as a handheld tool for air balancing functions in situations where the ISS is not required as an installed sensor.

J. The ISS menus provide function to configure the Terminal Control Unit (TCU) shall define items such as I/O configurations, set point and delays.

K. The configuration tool or through an Intelligent Space Sensor (ISS) menus shall allow to commission the TCU application and perform action such as inputs calibration, outputs override.

L. The ISS shall provide password protected menus or any other mechanism to prevent a local user to access advanced configuration menus including air flow balancing menu and network addressing.

M. Programmable to display up to ninety six (96) data points in any combination of local and/or networked values from any device on the internetwork.

N. Each ISS shall provide a point of access for a Service Tool, Supervisory Tool, etc. to the internetwork via the ISS communication port.

O. The ISS shall be capable of promoting good energy usage practices to the room occupant by displaying an Energy Consumption Indicator (ECI).
    1. The ECI shall be modified in real-time when the room occupant modifies a parameter of the Local Control Unit (LCU) or Terminal Controller Unit (TCU) such as the room temperature setpoint or the fan speed.
    2. The ECI shall indicate to the room occupant the energy impact of the parameter changes via a 5 level display icon where a full display (5^{th} level) indicates excellent energy conservation and no display indicating no energy conservation.
    3. The ECI follows the algorithm for energy efficiency as outlined in ASHRAE 55-2004.
    4. If ECI is not available then:
        a. A stainless steel plate with 4 LEDs must be mounted adjacent to the thermostat.
        b. The plate is to be engraved, adjacent to each LED, with symbology which will encourage the occupant to conserve energy.

c. ECI level (0 to 4) is to be indicated via digital outputs driving the LEDs.
d. Algorithm to be used; as defined in ASHRAE 55-2004

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

A. Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.3 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.

B. Continually monitor field installation for code compliance and workmanship quality.

C. Contractor shall arrange for work inspection by authorities having jurisdiction over the work.

3.4 WIRING

A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26 00 00, and manufacturer's recommendations. Where the requirements of this Section differ from other Divisions, this Section shall take precedence.

B. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC

C. Low-voltage wiring shall meet NEC Class 2 requirements. Sub fuse low-voltage power circuits as required to meet Class 2 current limit.

D. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.

E. Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.

F. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.

G. Do not install wiring in raceway containing tubing.

H. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 10 ft. intervals

I. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.

J. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.

K. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
   1. Include one pull string in each raceway 1 in. or larger.

L. Use color-coded conductors throughout.

M. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

N. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 6 in. between raceway and high-temperature equipment such as steam pipes or flues.

O. Adhere to requirements in Division 16 where raceway crosses building expansion joints.

P. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.

Q. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

R. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.

S. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.5 COMMUNICATIONS WIRING

A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).

B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

D. Verify entire network's integrity following cable installation using appropriate tests for each cable.

E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available.
   1. Runs that are longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

G. Label communication wiring to indicate origination and destination.

H. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

END OF SECTION 23 09 13

SECTION 23 09 13.13 - BAS ACTUATORS AND OPERATORS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. SECTION 23 09 00, BAS Instrumentation and Control

B. SECTION 23 09 13, BAS Instrumentation and Control Devices

C. SECTION 23 09 13.23, BAS Sensors and Transmitters

D. SECTION 23 09 13.43, BAS Control Dampers

E. SECTION 23 09 23, BAS Direct Digital Control System

1.2 REFERENCES

A. Refer to Section 23 09 00 - References

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 - PRODUCT

2.1 ACTUATORS

A. For dampers, the actuators used shall be provided from a single manufacturer

B. For valves, the actuators used shall be provided from a single manufacturer

C. Actuators shall be provided from a manufacturer registered under ISO9001:2000.

D. Electronic Damper Actuators.
   1. Size for torque required for damper seal at load conditions.
   2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
   3. Mounting: Actuators shall be capable of being mechanically and electrical paralleled to increase torque if required.
   4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
   5. Fail-Safe Operation: Mechanical, spring-return mechanism. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.
   6. Power Requirements (Two-Position Spring Return): 24 or 120 VAC as required.
   7. Power Requirements (Proportional): Maximum 10 VA at 24 VAC or 8 W at 24 VDC.

8. Temperature Rating: -22 to +122°F (-30 to +50°C)
9. Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
10. Agency Listing: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.

PART 3 - EXECUTION

3.1 ACTUATORS

A. General: Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators.
1. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation.
2. Link actuators according to manufacturer's recommendations.
3. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
4. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately the 5° open position, manually close the damper, and then tighten linkage.
5. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
6. Provide necessary mounting hardware and linkages for actuator installation.

END OF SECTION 23 09 13.13

SECTION 23 09 13.23 - BAS SENSORS AND TRANSMITTERS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. SECTION 23 09 00, BAS Instrumentation and Control

B. SECTION 23 09 13, BAS Instrumentation and Control Devices

C. SECTION 23 09 13.13, BAS Sensors and Transmitters BAS Actuators and Operators

D. SECTION 23 09 13.43, BAS Control Dampers

E. SECTION 23 09 23, BAS Direct Digital Control System

1.2 REFERENCES

A. Refer to Section 23 09 00 - References

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 - PRODUCT

2.1 SENSORS AND DEVICES

A. Input/output sensors and devices shall be closely matched to the requirements of the BAS controller for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.

B. Sensors and transmitters shall be manually calibrated on site so that the wiring length does not detract from the sensor accuracy specified.

C. Provide guards (plastic or wire) for sensors, thermostats, and transmitters that are installed in public areas such as gymnasiums, classrooms, corridors, and vestibules.

D. Temperature sensors shall have the following characteristics:
   1. Sensors shall have +/- 1.0 ˚F accuracy between 32 ˚F and 212 ˚F.
   2. Space temperature sensors
      a. Shall consist of an element within a ventilated cover.
      b. Space sensors located in mechanical rooms and public shall contain a network jack, but shall have no ability to adjust temperature setpoint (Set Point Adjustment).

c. Space sensors shall be provided in accordance with the drawings and specifications with the following options:
    i. Sensor complete with Network Jack
    ii. Sensor complete with Network Jack, and Set Point Adjustment
    iii. Sensor complete with Network Jack, and illuminated Override switch
    iv. Sensor complete with Network Jack, Set Point Adjustment, and illuminated Override switch
    v. Sensor complete with Network Jack, Set Point Adjustment, illuminated Override switch and Fan Speed Selection.

E. Temperature Sensor – Outside Air
1. Provide outside air temperature sensors as indicated within the field termination schedules and/or controls diagrams.
2. Temperature sensors shall meet, at minimum, the following requirements:
    a. Aluminum LB with PVC sun and windscreen.
    b. Wall mount weatherproof enclosure with conduit entrance.
    c. Thermistor or RTD compatible with BMS
3. Temperature sensors shall meet, at minimum, the following requirements:
    a. 0.25" stainless steel probe of length between one-third and two-thirds of the duct width.
    b. Thermistor or RTD compatible with BMS, sealed in probe with 3 part moisture protection system.
    c. Duct mounted ABS plenum rated housing with conduit entrance. (Optional metal, weather proof or no enclosure available)
4. Temperature sensors shall meet, at minimum, the following requirements:
    a. Probe length of 12 feet minimum or 1ft per ft^2 of duct cross-sectional area, whichever is greater.
    b. Copper sheathed or plenum rated flexible construction.
    c. Thermistor or RTD compatible with BMS.
    d. BMS shall report the monitored temperature with an accuracy of 2.0°F
    e. Duct mounted ABS plenum rated housing with conduit entrance. (Optional metal or weather proof available)
    f. Suitable supports at all bends and at intermediate points to prevent movement in the air systems.

F. Temperature Sensor – Wall Mounted – Lobby, Hallways Or Security Spaces
1. Provide wall mounted stainless plate temperature sensors for lobbies and lobby vestibule spaces as indicated within the field termination schedules and/or control diagrams as follows.
2. Temperature sensors shall meet, at minimum, the following requirements:
    a. Stainless plate sensors to fit 4" X 2" junction box, available with or without tamperproof screws.
    b. Thermistor or RTD compatible with BMS.

G. Relative Humidity Sensor – Outside Air

1. Provide OSA relative humidity sensors as indicated within the Field termination schedules and/or control diagrams. Humidity sensors shall meet, at minimum, the following requirements:
    a. ABS hinged weatherproof housing with conduit entrance.
    b. Sensor to be laser trimmed thermoset polymer based capacitive type.
    c. 24 Vac/dc power supply
    d. 4-20 mA two wire, 0-10 Vdc and 0-5 Vdc output proportional to relative humidity range of 0% to 100% and compatible with BMS.
    e. 2% accurate (5-95% RH).
    f. Operating temperature range of 32˚F to 185˚F.
    g. Reverse voltage protected and output limited.

H. Current Relay/Switch
1. Provide current sensing relays as indicated in the Field termination schedules and/or control diagrams. Current sensing relays shall meet, at minimum, the following specifications:
    a. Rated for the applicable load.
    b. The output relay shall have an accessible trip adjustment over its complete operating range. Provide LED indication of relay status.
    c. Current relay shall have input and output isolation via current transformer.
    d. Current relay shall be self-powered with no insertion loss.
    e. Relay shall be in a dustproof housing.
    f. Accuracy to be <2% of full-scale max.
    g. Temperature rating of 5˚F to 140˚F.
    h. Whenever the status of a single speed motor is monitored it shall be done via a current sensing relay.
    i. The BMS contractor shall provide current sensing relays at the MCC starters.
    j. The BMS contractor shall provide the current sensing relays for motors with local starters and no MCC starter.

I. Current Sensor
1. Provide monitoring of the current as identified in Field termination sheets and/or control drawings. Current monitoring shall meet, at minimum, the following requirements:
    a. 4-20 mA, 0-10 or 0-5 Vdc output proportional to current draw.
    b. Reverse polarity protected and output limited.
    c. 50/60 Hz operation.
    d. Accuracy of better than 1%.
    e. Operating temperature range of -20˚F to 120˚F.

J. Combination Room Temperature Sensor

1. Occupant-focused, communicating room sensor, providing precise temperature sensing, and optional lighting and shade/blind controls, for an all-in-one room device
    a. Device shall be a combination temperature sensor and input array that communicates with field controller.
    b. On board temperature sensor
        i. Range of 41˚F to 104˚F.
        ii. Accuracy of 0.9˚F.
        iii. Resolution of 0.18˚F.
    c. Dual connector ports for field controller connection shall support both power and communication, with provision for "daisy-chain" connection, so that more than one communicating sensor can be used with a single field controller. Dual connector ports shall be female RJ45 ports, and shall be compatible with standard Ethernet pinout T568B.
    d. Hardware options in combinations in any and all of the following:
        i. Temperature Setpoint Offset Adjustment
            a) "Infinite" Rotary Knob for setpoint offset
            b) LED Indication for setpoint offset: 3 Blue LEDs, 1 White LED, 3 Red LEDs
            c) LED indication can be reset regardless of knob position, to allow for nightly setpoint reset for example.
        ii. LED Indicator for Occupancy
        iii. "Infinite" Rotary Knob for fan speed adjustment
            a) LED Indication for fan speed adjustment: 5 LEDs corresponding to Fan settings of Auto, I, II, III, and Off
            b) LED indication can be reset regardless of knob position, to allow for nightly change to automatic fan speed, for example.
        iv. Available support for 8 digital inputs
            a) Support for dry contact signal from devices such as maintained or momentary switches
            b) Field wiring shall make use of on-board signal wiring "whip", to make best use of field connections without the need for screw terminals.
        v. Available support for up to 4 compact attachable modules. Attachable modules shall attach and be electronically connected with communicating sensor without the use of any field wiring. Each attachable module shall consume 2 digital inputs, as described above. Attachable modules shall be of the following types:
            a) Lighting module, for use with 1 lighting zone; Lighting module shall have engraved icons for indication of usage.
            b) Blind control module, for use with 1 group of window blinds or shades; Blind control module shall have engraved icons for indication of usage.

K. Discrete Combination Sensor
    1. Discrete communicating sensor combining precise environmental sensing – temperature, humidity and CO2- ideal for applications requiring no occupant driven overrides
    2. Dual connector ports for connection to field controller shall support both power and communication, with provision for "daisy-chain" connection, so that more than one communicating sensor can be used with a single field controller. Dual connector ports shall be female RJ45 ports, and shall be compatible with standard Ethernet pinout T568B.
    3. Hardware options in combinations of any and all of the following
        a. On board temperature sensor
            i. Range of 41˚F to 104˚F.
            ii. Accuracy of 0.9˚F.
        b. Resolution of 0.18˚F.On-board humidity sensor:
            i. Accuracy of 3% RH
            ii. Resolution of 1% RH
        c. Carbon Dioxide sensor:
            i. Range of 0-2000 ppm
            ii. Operating Elevation 0-16000 ft
            iii. Accuracy of 30 ppm in range of 400-1250 ppm, or 3% of reading, whichever is higher
            iv. Accuracy of 30ppm +/- 5% of reading in range of 1250 to 2000 ppm
            v. Sensing Method of Non-Dispersive Infrared (NDIR) Absorption with gold-plated optics
            vi. Periodic, automatic self-calibration using patented ABC Logic
    4. Continuous operating temperature of standard versions shall be 221°F [105°C].
    5. Enclosure shall be NEMA-6P [IP 68]v
        a. The metering system shall operate over a flow range of 0.10 to 39.4 ft/s .
        b. The metering system shall perform to an accuracy ± 0.25 percent of rate for velocities greater than 1.64 ft/s, ± 0.004 ft/s for velocities less than 1.64 ft/s.
        c. Measuring range 0.5 to 30 ft/s
    6. Continuous operating temperature of standard versions shall be 221°F.

PART 3 - EXECUTION

3.1 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.

D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.

E. Install outdoor air temperature sensors on north wall at designated location with sun shield.

F. Smoke detectors, high and low limit thermostats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

END OF SECTION 23 09 13.23

SECTION 23 09 13.43 - BAS CONTROL DAMPERS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. SECTION 23 09 00, BAS Instrumentation and Control

B. SECTION 23 09 13, BAS Instrumentation and Control Devices

C. SECTION 23 09 13.13, BAS Actuators and Operators

D. SECTION 23 09 13.23, BAS Sensors and Transmitters

E. SECTION 23 09 23, BAS Direct Digital Control System

1.2 REFERENCES

A. Refer to Section 23 09 00 – References

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 - PRODUCT

2.1 AUTOMATIC CONTROL DAMPERS

A. Manufacturer shall submit leakage data for all control dampers with the temperature control Dampers shall be minimum leakage type to conserve energy and the temperature control submittal.

B. Damper leakage ratings shall be certified in accordance with AMCA Standard 500-D.

C. Provide any automatic control dampers not specified to be integral with other equipment.

D. Provide automatic control dampers as specified herein:
   1. Frame construction shall not be less than 14 gauge galvanized steel or extruded aluminum at a minimum 4-1/2” X 1” X 0.125” in thickness.
   2. Blades shall be single skin and not less than 16-gauge galvanized steel roll formed or extruded aluminum. Blades shall not be over: 8” wide, 48” in length and 72” high.
   3. All blade edges and top and bottom of frame shall be provided with compressible seals. Side seals shall be compressible stainless steel of the tight-seal spring type.
   4. Blade seals shall provide for a maximum leakage rate of 10 CFM per square

foot at 2.5 inches of WC differential pressure. Dampers and seals shall be suitable for temperature ranges of -40 to 180 ˚F.

5. Bearings shall corrosion resistant, molded synthetic sleeve type turning in an extruded hole in the damper frame.
6. Axles shall be a minimum of ½" diameter and be welded to blade or riveted to blade
7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6".
8. Where ultra-low leakage dampers are specified the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 6 CFM per square foot for dampers in excess of sixteen inches square at 1 inch of WC.
9. Individual damper sections shall not be larger than 48" X 60". Provide a minimum of one damper actuator per section.
10. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
11. Combination automatic smoke control dampers, where indicated on the plans, shall conform to the UL555S Leakage Class specified.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate delivery of dampers to site.

B. Clearly tag and mark dampers for their purpose and location.

C. Supervise Mechanical Contractor in the installation of the dampers ensuring proper dampers(s) are located and installed in proper location(s)

END OF SECTION 23 09 13.43

SECTION 23 09 23 - BAS DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. SECTION 23 09 00 BAS Instrumentation and Control

B. SECTION 23 09 13, BAS Instrumentation and Control Devices

C. SECTION 23 09 13.13, BAS Actuators and Operators

D. SECTION 23 09 13.23, BAS Sensors and Transmitters

E. SECTION 23 09 13.43, BAS Control Dampers

1.2 REFERENCES

A. Supplementing 23 09 00 1.2 References requirements.
   1. ANSI/ASHRAE 135-2004, BACnet®[1] - A Data Communication Protocol for Building Automation and Control Networks including Addendums 135-2004a, 135-2004c, 135-2004d, 135-2004e, 135-2004f

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Supplementing 23 09 00 1.3 Acronyms, Abbreviations and Definitions requirements
   1. .Acronyms used in BAS.
      a. AI - Analog Input
      b. AO - Analog Output
      c. BACnet® - Building Automation and Control Network
      d. BAS - Building Automation System
      e. CAD - Computer Aided Design
      f. CDL - Control Description Logic
      g. COSV - Change of State or Value
      h. CPU - Central Processing Unit
      i. DI - Digital Input
      j. DO - Digital Output
      k. ECU - Equipment Control Unit
      l. IDE - Interface Device Equipment
      m. LAN - Local Area Network
      n. LCU - Local Control Unit
      o. NCU - Network Control Unit
      p. Niagara4 – Software framework for building device-to-enterprise applications and Internet-enabled products.
      q. OS - Operating System
      r. OWS - Operator Work Station

[1] a registered trademark of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

s. PC - Personal Computer
t. PCI - Peripheral Control Interface
u. PCMCIA - Personal Computer Micro Card Interface Adapter
v. RAM - Random Access Memory
w. ROM - Read Only Memory
x. TCU - Terminal Control Unit
y. USB - Universal Serial Bus
z. UPS - Uninterruptible Power Supply

B. Definitions:
1. Point: a point may be logical or physical. Logical points are values calculated by system such as totals, counts, derived corrections i.e. as result of and/or statements in CDL's. Physical points are inputs or outputs, which have hardware, wired to controllers which are measuring or providing status conditions of contacts or relays providing interaction with related equipment (stop, start) or valve or damper actuators.

C. Symbols and Engineering unit abbreviations utilized in displays: to ANSI/ISAS 5.5.
1. Printouts: to ANSI/IEEE 260.

1.4 BAS CONTRACTOR QUALIFICATIONS

A. Supplementing 23 09 00 1.12 BAS Contractor Qualifications.
1. The contractor must be regularly engaged in the service and installation of BACnet and Niagara4 as specified herein,
2. The Contractor must be regularly engaged in the service and installation of BACnet, LONWORKS and Niagara4 as specified herein,
3. The Contractor shall have a minimum of 5 years' experience in the sales, installation, engineering, programming servicing and commissioning of Niagara4.
4. The Contractor must be an authorized factory direct representative in good standing of the manufacturer of the proposed hardware and software components. Provide a letter dated within the last 12 months, from the manufacturer certifying that the Contractor is an authorized factory direct representative.
5. The Contractor shall a minimum of three (3) technicians who have successfully completed the factory authorized training of the proposed manufactures hardware and software components and have successfully completed Niagara4 certification course(s).
a. Contractor must provide proof of required training.
b. The Contractor's capabilities shall include engineering and design of control systems, programming, electrical installation of control systems, troubling shooting and service.
6. The contractor shall submit a list of no less than three (3) similar (in function, application and design) projects, which have similar Building Automation Systems as specified herein installed by the Contractor.
a. These projects must be on-line and functional such that the Owner's/User's representative can observe the system in full operation.

1.5 GENERAL DESCRIPTION

A. Supplementing 23 09 00 1.5 General Description requirements.
   1. System to be "Open Protocol".
      a. BACnet® communications protocol will be used for communications.
   2. Work covered by sections referred to above consists of fully operational BAS, including, but not limited to, following:
      a. Building Controllers NCU, LCU, TCU.
      b. OWSs.
      c. Data communications equipment necessary to achieve an BAS data transmission system including LAN hardware and software for a BACnet® system
      d. Software complete with full documentation for software and equipment.

1.6 WORK INCLUDED

A. Supplementing 23 09 00 1.10 Work Included requirements.

B. Provide a new building automation system to control and monitor the building's mechanical and electrical systems.
   1. The system installed shall seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC, lighting, and security devices should easily coexists on the same network channel without the need for gateways.
   2. Components not supplied by the primary manufacturer shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.

C. The Installer furnishing the BAS network shall meet with the Installer(s) furnishing each of the following products to coordinate details of the interface between these products and the DDC network.
   1. The variable frequency drive (VFD) vendor shall furnish VFDs with an interface to the control and monitoring points specified utilizing:
      a. Hardwired connections such as relay(s), 0-10VDC, or 4-20mA.
      b. BACnet/IP network connection.
      c. BACnet MS/TP network connection

D. Provide new controllers of the latest revisions with input and output points as specified herein.

E. Furnish and install all controllers to achieve system operation, any control devices, conduit and wiring, in the facility as required to provide the operation specified.

F. Furnish and load all software required to implement a complete and operational BAS.

1.7 SYSTEM DESIGN RESPONSIBILITY

A. Supplementing 23 09 00 1.13 System Design Responsibility requirements.
   1. Supply sufficient programmable controllers of all types to meet project requirements. Quantity and points contents to be approved by Owner prior to installation.
      a. Local Control Units (LCU) shall be utilized for primary mechanical and electrical systems such as Air handling equipment, Make-up Air Unit, Boiler System Control, and Chiller System Control type of applications.
      b. Terminal Control Units (TCU) shall be utilized for terminal equipment, such as Variable Air Volume, Fan Coil, Heat Pump, Roof Top, and Chilled Ceiling type of applications.
      c. Each LCU and TCU controller shall have a minimum of 10% spare capacity of each point type for future points. As a minimum, each controller shall have one spare of each point type available on the controller.
      d. Each NCU and each LAN shall have the capability of accepting 20% additional LCU/TCU(s) without the necessity of adding additional LAN controllers or LAN wiring.
      e. The LCU and TCU controller programming or configuration tools (see section 23 09 13 2.2**Error! Reference source not found. Error! Reference source not found.**) shall be fully accessible through the Operator Workstation and Web Browser Client.
      f. All LCUs and TCUs shall be furnished with extended memory. No LCU/TCU shall be provided with less than 128 MB of RAM. The number of controllers attached to any NCU shall not exceed the following limits:

Combined Memory	Maximum Number of Controllers
128 MB SDRAM / 64 MB Serial Flash	25
256 MB DDR RAM / 128 MB Serial Flash	50
1 GB DDR2 RAM / 1 GB Serial Flash	125

   2. Regardless of the maximum number of controllers indicated above, it is ultimately the exclusive responsibility of the systems integrator/building controls contractor to ensure that the NCU has adequate resources for the number of controllers attached to it.
   3. Niagara4 Network Manager Server software shall be furnished and installed on a server grade PC for applications requiring two or more NCUs.

1.8 BUILDING AUTOMATION SYSTEM (BAS)

A. The contractor shall be responsible for the hardware and software for the enterprise framework and system integration required for the complete Building Automation System.

B. The BAS shall be comprised of Network Control Units (NCU) connected to the Building Automation System local area network (BAS LAN).
   1. Access to the BAS, either through a Workstation on the BAS LAN, within the building or through a Wireless Application Protocol device, or remotely through the Internet, shall be accomplished through a standard Web browser.
   2. Each NCU shall communicate to BTL Listed BACnet controllers provided under the Programmable Controllers section.

C. The system includes software and programming of the NCU(s), Operator Workstation(s) (OWS) software and hardware, development of all graphical screens, setup of schedules, trends, logs and alarms, network management and connection of the NCU(s) to the local area network.

1.9 SYSTEM DESIGN

A. The system shall consist of a network of Network Control Units (NCUs), interoperable Local Control Units (LCUs) and Terminal Control Units (TCUs) (VAV Box Controllers, Fan Coil Unit Controllers, etc.). All controllers for terminal units, air handling units (AHU) and controllers shall communicate and share data, utilizing BACnet communications protocols only

B. The system shall consist of a network of Network Control Units (NCUs), interoperable Local Control Units (LCUs) and Terminal Control Units (TCUs) (VAV Box Controllers, Fan Coil Unit Controllers, etc.). All NCUs and associated controllers will utilize BACnet communication protocols. All controllers for terminal units, air handling units (AHU) and controllers shall communicate and share data, utilizing LonWorks communications protocols only.

C. The intent of this specification is to provide a distributed and networked open Building Automation System, the capability to integrate ANSI/ASHRAE Standard 135, BACnet and ISO/IEC 14908-1: Open Data Communication in Building Automation, Controls and Building Management – Control Network Protocol into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.

D. The intent of this specification is to provide a distributed and networked open Building Automation System, the capability to integrate LonWorks communication technologies into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.

E. The intent of this specification is to provide a distributed and networked open Building Automation System, the capability to integrate ANSI/ASHRAE Standard 135, BACnet and ISO/IEC 14908-1: Open Data Communication in Building Automation, Controls and Building Management – Control Network Protocol and LonWorks communication technologies into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.

F. The proposed system must maintain strict adherence to industry standards including ANSI/ASHRAE Standard 135, Annex L, and Device Profile to assure interoperability between all system components. BACnet system must be tested and listed on BACnet Testing Laboratory (BTL) web site. Systems based on vendor specific proprietary hardware or software will not be considered for this project.

G. The proposed system must maintain strict adherence to industry standards including Functional Profiles identified in LonMark Interoperability Guideline standards to assure interoperability between all system components. LonWorks system must be certified and listed on LonMark web site. Systems based on vendor specific proprietary hardware or software will not be considered for this project.

H. Systems utilizing gateways to proprietary communication systems will not be considered for this project. A gateway is considered to be a device or controller where the sole function is mapping of data points from one protocol to another. A gateway device cannot perform higher-level energy management functions such as Outdoor Air Optimization, Electrical Demand Limiting and the like.

I. The supplied system software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI/ASHRAE™ Standard 135, BACnet to assure interoperability between all system components is required.

J. The supplied system software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including LonMark to assure interoperability between all system components is required.

K. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a flat single tiered architecture shall not be acceptable. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 10 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

L. User Access

1. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs.

M. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system databases, all controller program graphics and network databases which shall be provided in a Niagara4 Framework format.
   1. This data shall reside on a supplier-installed server for all database access.
   2. Systems requiring proprietary database and user interface programs shall not be acceptable.

N. Software Tools
   1. All software tools needed for full functional use, including programming of controllers, Niagara4 Framework network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner or his designated agent.
      a. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided.
      b. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent.
      c. Any cost associated with the license changes shall be identified within the BAS submittals.

O. Software License Agreement
   1. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract.
   2. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.
      a. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).
      b. In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project.
      c. This shall include all custom, job specific software code, databases and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NCU, Server, OWS and any related LAN/WAN/Intranet and Internet connected routers and devices.
      d. Any and all required User IDs and passwords for access to any component or software program shall be provided to the owner.

1.10 DYNAMIC DATA ACCESS

A. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

1.11 NETWORKS

A. The BAS network(s) must be based on Open Systems.

B. Niagara4 shall be used at the network levels as the manager(s).

C. High-speed data transfer rates for alarm reporting, quick report generation form multiple controllers and upload/download efficiency between network devices.

D. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.

E. Detection and accommodation of single or multiple failures of workstations, controller panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

F. Message and alarm buffering to prevent information from being lost.

G. Error detection, correction, and retransmission to guarantee data integrity.

H. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.

I. Commonly available, multiple sourced, networking components shall be used to allow the system to coexist with other networking applications such as office automation. Ethernet to IEEE 802.3 standard is the only acceptable technology.

J. Synchronization of the real-time clocks in all NCU panels shall be provided.

K. The BAS LAN shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, SOAP, OBIX, SNMP and SMTP Protocols for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Control Units (NCUs), user workstations and where specified, a local server. Local area network minimum physical and media access requirements:
   1. Ethernet; IEEE standard 802.3
   2. Cable; 100 Base-T, UTP-8 wire, category 5

3. Minimum throughput; 100 Mbps
4. Provide access to the BAS LAN via a Wireless Application Protocol (WAP) device. Through this connection the BAS LAN will provide authorized staff with the ability to monitor and control the BAS from any location within the through a web browser, or web enabled devices.
5. Provide access to the BAS LAN from a remote location, via the Intranet or Internet. The owner shall provide (in future) a connection to the Internet to enable access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or access to an Internet Service Provider (ISP). If required, the owner will provide a switch/firewall between the building LAN and the BAS LAN. Through this connection the BAS LAN will provide authorized staff with the ability to monitor and control the BAS from a remote location through a web browser, or web enabled devices.

L. Controller Local Area Network (BAS sub LAN)
1. Provide a network of stand-alone, distributed direct digital controllers that operate on the following protocol using the specified physical layers:
   a. The BAS sub LAN shall employ the BACnet protocol for communication between controllers. BACnet protocol implementation shall adhere to the ANSI/ASHRAE Standard 135. Communications between BACnet devices shall be 76.8 kbps over approved twisted shielded pair cabling utilizing Master/Slave Toke Passing BACnet protocol. BACnet defines a comprehensive set of object types and application services for communication requirements among all levels of control in a distributed, hierarchical Building Automation System. BACnet is intended to provide a single, uniform standard for the BAS to provide the required interoperability.
   b. The BAS sub LAN will employ LonWorks communications utilizing the Echelon Neuron chip and transceiver, which conforms to ISO/IEC 14908-1: Open Data Communication in Building Automation, Controls and Building Management – Control Network Protocol. The content of messages shall be the manufacturers standard. The Neuron chip and a transformer-isolated transceiver shall provide for 78.8 kbps communications over Echelon approved LonWorks cabling.
2. Strict adherence to industry standards including ANSI/ASHRAE Standard 135, BACnet, certified by BACnet Testing Laboratory (BTL listed) to assure interoperability between all system components. Controllers that are not BTL listed are unacceptable.
3. Strict adherence to industry standards including Functional Profiles identified in LonMark (LonMark certified) standards to assure interoperability between all system components. Controllers that are not LonMark certified are unacceptable
4. Provide BAS Controllers that conform to ANSI/ASHRAE Standard. 135, BACnet
5. Provide BAS Controllers that conform to LonWorks technology and are LonMark certified.

a. Controllers using proprietary protocols or protocols other than listed herein are unacceptable.

6. The design of the BAS sub LAN shall network Local Control Unit (LCU) and Terminal Control Unit (TCU) to a Network Control Unit (NCU).
7. This level of communication shall support a family of application specific controllers and shall communicate bi-directionally with the network through DDC Controllers for transmission of global data.
8. Terminal Control Unit (TCU) shall be arranged on the BAS sub LAN's in a functional relationship manner with Local Control Unit (LCU). Ensure that a Variable Air Volume (VAV) Terminal Control Unit (TCU) is logically on the same LAN or segment as the Local Control Unit (LCU) that is controlling its corresponding Air Handling Unit (AHU).

PART 2 - PRODUCTS

2.1 QUALITY ASSURANCE

A. Supplementing 23 09 00 2.1 Quality Assurance requirements.

1. The manufacturer of the Building Automation System digital controllers shall provide documentation supporting compliance with ISO 9001:2000 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing).
2. Provide a copy of the registration certificate that contains the ISO 9001:2000 Certification bearing the name of the registered auditor.
3. Control products such as direct digital controllers, control valves, actuators, sensors and transmitters shall be provided from a single manufacturer.
   a. Provide product literature that bears the name of the manufacturer on all direct digital controllers, control valves, actuators, sensors and transmitters.
4. Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.
5. All controllers provided as part of this system and used for indoor applications shall operate under ambient environmental conditions of 32 ˚F to 122 ˚F dry bulb and 5% to 90% relative humidity, non-condensing as a minimum.
6. All controllers provided as part of this system and used for outdoor applications shall operate under ambient environmental conditions of -40 ˚F to 158 ˚F dry bulb and 5% to 90% relative humidity, non-condensing as a minimum.

2.2 ACCEPTABLE SYSTEM MANUFACTURERS

A. Provide a building automation system supplied by a company regularly engaged in the manufacturing and distribution of building automation systems. The BAS Manufacturer shall meet the following qualifications as a minimum:
    1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of building automation systems as specified herein, and must have been so for a minimum of five (5) years.
    2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International.
    3. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the LonMark Association.
    4. At least 75% of the manufactured product line shall be produced under their own direction, including R&D and assembly. Rebranding of another manufacture product shall not qualify.

B. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

C. Acceptable Manufacturers
    1. Distech Controls as provided by TEMPSET CONTROSL INC. Contact Larry Hartgrove 512 259 5285.

D. If a manufacturer or vendor, other than those listed in 'C Acceptable Manufacturers' wishes to seek equivalency to any of the above controls offerings, then the manufacturer or vendor will be subject to the original pre-qualification criteria that were used to qualify the 'Acceptable Manufacturers'. Failure to meet the qualifications will render the proposed solution by such a manufacturer or vendor as ineligible.

PART 3 - EXECUTION

3.1 PRELIMINARY DESIGN REVIEW

A. Supplementing 23 09 00 3.8 Preliminary Design Review requirements.
    1. The BAS contractor shall submit a preliminary design document for review. This document shall contain the following information in addition to the requirements of 23 09 00:
        a. Provide product brochures and a technical description of the Server, Operator Workstation, and Network Control Unit (NCU) software required to meet this specification. Provide a description of software programs included.

b. Open Protocols - For all direct digital controller hardware BACnet Protocol Implementation Conformance Statement PICS. Provide complete description and documentation of any proprietary services and/or objects where used in the system.
c. Open Protocols - For all direct digital controller hardware proof of conformance to LonMark Certification and interoperability guidelines including the provision of all controller XIF files. Provide complete description and documentation of any proprietary services and/or objects where used in the system.
d. Submit the Niagara Compatibility Statement (NiCS) verifying that all aspects of the Niagara Framework as provided to maintain an Open System Design. The System as provided shall confirm with the following NiCS properties.

i.	Property	ii.	Value
iii.	Station Compatibility IN	iv.	All
v.	Station Compatibility OUT	vi.	All
vii.	Tool Compatibility IN	viii.	All
ix.	Tool Compatibility OUT	x.	All

2. Provide a description and samples of Operator Workstation graphics and reports.
3. Provide a URL address for the engineer to view the proposed functionality via a web based BAS through a standard web browser.

3.2 SUBMITTALS

A. Supplementing 23 09 00 3.9 Submittals requirements.
1. Control System Shop Drawings
a. Detailed system architecture and points list showing all points associated with each controller, controller locations, and describing the spare points capacity at each controller and BAS LAN.
2. Direct Digital Control System Hardware
a. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of BACnet controller.
b. Bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
c. Manufacturer's description and technical data such including product specifications and installation and maintenance instructions for items listed herein:
i. Direct digital controllers (BACnet)
ii. Sensors and Transmitters
iii. Transducers
iv. Actuators
v. Automatic Control Dampers
vi. Control panels
vii. Operator interface equipment

viii. Ancillary equipment such as relays, power supplies and wiring

d. Riser diagrams showing control network layout, communication protocol, and wire types.

3. Building Automation System Server and Operator Workstation (OWS)
   a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
   b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
      i. Central Processing Unit (CPU) or web server
      ii. Monitors
      iii. Keyboards
      iv. Uninterruptible Power supplies
      v. Network switches, hubs and routers.
      vi. Interface equipment between CPU or server and control panels
      vii. Operating System software
      viii. Operator interface software
      ix. Color graphic software
      x. Third-party software
   c. Network diagram of control, communication, and power wiring for BAS Server and OWS installation.

END OF SECTION 23 09 23

SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

1.3 DEFINITIONS

A. DDC: Direct digital control.

1.4 HEATING - FURNACES

A. Single temperature room thermostat set at 72 degrees F maintains constant space temperature by energizing gas heating section of fan coil unit / furnace.

1.5 COOLING – FCU'S

A. Single temperature room thermostat set at 75 degrees F maintains constant space temperature by energizing cooling section of fan coil unit / outdoor unit.

1.6 VENTILATION SEQUENCES

A. Exhaust Fan: Interlock and controlled with switch / timer switch. Refer to plans.

B. Kitchen Exhaust Fan: Control at hood starts/stops fan.

1.7 UNIT HEATERS

A. Single temperature electric room thermostat maintains constant space temperature of 55 degrees F by cycling unit fan motor and heat exchanger.

1.8 FAN COIL UNITS

A. Change over from heating to cooling by indexing thermostat. When supply is above room temperature, unit to be in cooling mode. When supply is below room temperature, unit to be in heating mode.

1.9 VRV UNITS

A. Change over from heating to cooling by indexing thermostat. When supply is above room temperature, unit to be in cooling mode. When supply is below room temperature, unit to be in heating mode. Refer to manufacturer spec for further control and sequencing.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 09 93

SECTION 23 11 26 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Service Regulators: 65 psig minimum unless otherwise indicated.
2. Minimum Operating Pressure of Service Meter: 20 psig.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified

professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Service meters. Indicate pressure ratings and capacities. Include supports.
5. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified. professional engineer

B. Welding certificates.

1.7 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Construction Manager no fewer than [two]<Insert number> days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.

d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

a. Steel flanges and tube with epoxy finish.
b. Buna-nitrile seals.
c. Steel bolts, washers, and nuts.
d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inchand smaller.
6. Service Mark: Valves 1-1/4 inchesto NPS 2shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated brass.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Separate packnut with adjustable-stem packing threaded ends.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inchesin diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.

3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2and smaller; flanged for regulators NPS 2-1/2and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

2.7 SERVICE METERS

A. Diaphragm-Type Service Meters: Comply with ANSI B109.1.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. <Insert manufacturer's name>

3. Case: Die-cast aluminum.
4. Connections: Steel threads.
5. Diaphragm: Synthetic fabric.
6. Diaphragm Support Bearings: Self-lubricating.
7. Compensation: Continuous temperature and pressure.
8. Meter Index: Cubic feet.
9. Meter Case and Index: Tamper resistant.
10. Remote meter reader compatible.
11. Maximum Inlet Pressure: 100 psig.
12. Pressure Loss: Maximum 0.5-inch wg.

13. Accuracy: Maximum plus or minus 1.0 percent.

2.8 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psigminimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psigminimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.9 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 incheswide and 4 milsthick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inchesdeep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to [NFPA 54][the International Fuel Gas Code] to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with [NFPA 54][the International Fuel Gas Code] requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with [NFPA 54][the International Fuel Gas Code] for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gage downstream from each service regulator. Pressure gages are specified in Section 23 05 19 "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with [NFPA 54][the International Fuel Gas Code] for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to

size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. Install unions in pipes NPS 2and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

R. Do not use natural-gas piping as grounding electrode.

S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

T. Install pressure gage downstream from each line regulator. Pressure gages are specified in Section 23 05 19 "Meters and Gages for HVAC Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground, on concrete bases.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 05 50 00 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.9 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

A. Comply with requirements in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.

c. Topcoat: Exterior alkyd enamel(semigloss).
d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex(eggshell).
d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd(eggshell).
d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to [NFPA 54][the International Fuel Gas Code] and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.14 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

D. Valves in branch piping for single appliance shall be the following:

1. One-piece, bronze ball valve with bronze trim.

END OF SECTION 23 11 26

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Pressure-regulating valves.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.8 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

2.2 VALVES AND SPECIALTIES

A. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

B. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

C. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

D. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F
6. Superheat: Adjustable.
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 700 psig.

E. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

F. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

G. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. End Connections: Socket.
5. Access Ports: NPS 1/4connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

H. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Hot-Gas and Liquid Lines: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Hot-Gas and Liquid Lines: Copper, Type K or L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

D. Hot-Gas and Liquid Lines: Copper, Type K or L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

E. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

F. Safety-Relief-Valve Discharge Piping: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

G. Safety-Relief-Valve Discharge Piping: Copper, Type K or L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

H. Safety-Relief-Valve Discharge Piping: Copper, Type K or L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a full-sized, three-valve bypass around filter dryers.

C. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

D. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

E. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

G. Install filter dryers in liquid line between compressor and thermostatic expansion valve , and in the suction line at the compressor.

H. Install receivers sized to accommodate pump-down charge.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design

considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feetlong.
2. Roller hangers and spring hangers for individual horizontal runs 20 feetor longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feetor longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.
b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 23 31 16 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 23 31 19 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" ASCE/SEI 7.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Natural-Fiber Duct Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested according to ASTM C 518.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to ASTM E 84; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

C. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
    a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    b. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    d. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and

Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

B. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

B. Related Requirements:

1. Section 23 37 23 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Section 28 31 11 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
3. Section 28 31 12 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances;

and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product ct to compliance with requirements, or comparable product by one of the following:

1. Ruskin
2. Greenheck
3. Nailor

C. Description: Gravity balanced.

D. Maximum Air Velocity: 1250 fpm.

E. Maximum System Pressure: 2-inch wg.

F. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners or mechanically attached.

G. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

H. Blade Action: Parallel.

I. Blade Seals: Felt.

J. Blade Axles:

1. Material: Stainless steel.
2. Diameter: 0.20 inch.

K. Tie Bars and Brackets: Aluminum.

L. Return Spring: Adjustable tension.

M. Bearings: Steel ball.

N. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Screen Material: Galvanized steel.
4. Screen Type: Bird.

2.4 MANUAL VOLUME DAMPERS

A. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product ct to compliance with requirements, or comparable product by one of the following:

    a. Ruskin

    b. Greenheck

    c. Nailor

3. Comply with AMCA 500-D testing for damper rating.
4. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
5. Suitable for horizontal or vertical applications.
6. Frames:

    a. Hat shaped.
    b. 0.094-inch-thick, galvanized sheet steel.
    c. Mitered and welded corners.
    d. Flanges for attaching to walls and flangeless frames for installing in ducts.

7. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized, roll-formed steel, 0.064 inch thick.

8. Blade Axles: Nonferrous metal.
9. Bearings:

    a. Oil-impregnated stainless-steel sleeve.
    b. Dampers in ducts with pressure classes of 3-inch wgor less shall have axles full length of damper blades and bearings at both ends of operating shaft.

10. Blade Seals: Felt.
11. Jamb Seals: Cambered stainless steel.
12. Tie Bars and Brackets: Galvanized steel.
13. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inchhexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product ct to compliance with requirements, or comparable product by one of the following:

1. Ruskin
2. Greenheck
3. Nailor

C. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

D. Frames:

1. Hat shaped.
2. 0.094-inch-thick, galvanized sheet steel.
3. Mitered and welded corners.

E. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch thick single skin.
5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

F. Blade Axles: 1/2-inch-diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

G. Bearings:

1. Oil-impregnated stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product ct to compliance with requirements, or comparable product by one of the following:

1. Ruskin

2. Greenheck

3. Nailor

C. Type: Static; rated and labeled according to UL 555 by an NRTL.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream, Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05, thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Heat-Responsive Device: replaceable link and switch package, factory installed, 165 deg F rated.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements:

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

    a. Double wall, rectangular.
    b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    c. Vision panel.
    d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements:

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inchmovement at start and stop.

2.9 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements,:

B. Basis-of-Design Product ct to compliance with requirements, or comparable product by one of the following:

1. Thermaflex
2. Hart and Cooley
3. Flexmaster

C. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.10 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

I.

1. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
2. Control devices requiring inspection.
3. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. Head and Hand Access: 18 by 10 inches.

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inchmovement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

END OF SECTION 23 33 00

SECTION 23 34 16 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: For each product.

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Forward-curved centrifugal fans.
4. Plenum fans.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
1. Vibration Isolators: Spring isolators having a static deflection of 1 inch.

2.2 AIRFOIL CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

B. Basis-of-Design Product: Subject to compliance with requirements, or comparable product by one of the following:

1. Greenheck
2. Cook
3. Twin City Fans

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

D. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Spun inlet cone with flange.
4. Outlet flange.

E. Airfoil Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

F. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Companion Flanges: Rolled flanges for duct connections of same material as housing.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, or a comparable product by one of the following:

1. Greenheck
2. Cook
3. Twin City Fans

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

D. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Spun inlet cone with flange.
4. Outlet flange.

E. Backward-Inclined Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

F. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: **1.5**.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through **5** hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Companion Flanges: Rolled flanges for duct connections of same material as housing.

2.4 FORWARD-CURVED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, or a comparable product by one of the following:

1. Greenheck

2. Cook

3. Twin City Fans

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

D. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Spun inlet cone with flange.
4. Outlet flange.

E. Forward-Curved Wheels:

1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

F. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through **5** hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Companion Flanges: Rolled flanges for duct connections of same material as housing.

2.5 PLENUM FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements or a comparable product by one of the following:

1. Greenheck
2. Cook
3. Twin City Fans

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

D. Airfoil Wheels:

1. Single-width-single-inlet construction with smooth-curved inlet flange.
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.
2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000.
3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000.

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

F. Unit Support: Install centrifugal fans level. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.

1. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for flexible duct connectors.
2. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation and seismic-control devices.

H. Install units with clearances for service and maintenance.

I. Label fans according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 34 16

SECTION 23 35 16 - STRAIGHT RAIL VEHICLE EXHAUST REMOVAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Conditions of the Contract and portions of Division One of this Project Manual apply to this Section as though repeated herein.

1.2 SUMMARY

A. Provide all labor, materials, and equipment necessary to put in working operation a complete turnkey system to remove both diesel and automotive exhaust gases and particulate of operating vehicles within the confines of specified fire station(s). All necessary controls, motors, fittings, ductwork, blower(s), labor and all other equipment and materials specified shall be part of the work.

B. Section Includes:

1. Exhaust System General Components
   a. Support Legs.
   b. Upper Flexible Hose.
   c. Lower Hose Assembly.
   d. Safety Disconnect Coupling.
   e. Collection Nozzle Assembly.
   f. Manual Fill Valve.
   g. Hose "Saddle" Rigid Elbow
   h. Electrical Controllers.
   i. Air Moving Devices.
   j. Ductwork System.
2. Straight Rail Specific Components
   a. Rail Material.
   b. Top Mounting Suspension.
   c. Mechanical Brake System.
   d. Rail Splicing Joint.
   e. Middle Rail Duct Connection.
   f. Trolley Assembly.

C. All items of equipment and materials described in these specifications are to be furnished installed and placed into proper operating condition in accordance with good practice and manufacturer's written or published instructions.

The exhaust removal system shall provide virtually 100 percent complete evacuation of all diesel fumes at the source from start up to exit of the apparatus from the fire station. The diesel exhaust removal system shall be capable of delivering complete coverage for bays up to 60 feet (18.3M) in length. The system must be able to accommodate drive through and back-in bays to meet all the needs of the fire department.

1. System must be designed and installed to NIOSH recommendation, specifying that occupational exposures to carcinogens be limited to the lowest feasible concentration. Exposure in the human

breathing zone should be limited to lowest feasible level, without any time delay required for the system to effectively capture the diesel fumes.

2. System must also be capable to provide virtually complete capture and evacuation of carbon monoxide emitted as part of the vehicle exhaust.
3. Systems that solely use filters, in which diesel particulate may accumulate, and that would potentially have to be treated as hazardous materials, will not be accepted.
4. System must meet the guidelines for the International Mechanical code for Source Capture Systems. Such system is defined as a mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.
5. The system shall not affect personnel boarding the apparatus. Hose loops shall not hang any lower then six feet from the bay floor. The hose assembly shall not come into contact with the vehicle other than one connection point to the vehicles tailpipe. The hose assembly shall not touch or drag on the bay floor.
6. The exhaust system shall not block doorways, exits, and aisles in the apparatus bay, which could endanger the welfare of fire personnel or visitors.
7. The exhaust system shall not need to be disconnected from the vehicle while shore lines are connected, during battery charging, or washing of the vehicle, as with other types of systems.
8. To protect the apparatus electrical system from possible damage, the system bid shall not incorporate any type of electromagnetic device that requires the apparatus to be utilized as an electrical ground for systems operation.
9. Due to the harmful effects of diesel exhaust, the system must be designed and capable of capturing virtually 100% of the exhaust gas and virtually 100% of the particulate even in the event of a complete power failure. The system shall not detach itself from the apparatus for any reason during a power failure other then normal exiting of the apparatus bay. System shall discharge exhaust outside the station even in the event of a power failure.
10. The system shall capture the exhaust gases and particulate directly from the tailpipe of the apparatus by a direct connected “visible” high temperature rated hose. Particulates emitted from the apparatus are known to be heavier than air and therefore must be captured by a directly connected hose with a tight seal, as loose nozzles or air filters cannot capture these heavy particulates. The particulates have been documented to be the main respirable carcinogen in diesel exhaust, and therefore are the primary concern of the fire department to capture virtually 100% of these particulates.

1.3 SUBMITTALS

A. Product Data: Indicate manufacturer's model number, technical data including description of com ponents and static pressure/air flow chart, and installation instructions.

1. Details of wiring for power differentiating between manufacturer-installed and field-installed wiring.

B. Closeout Submittals: Operation and Maintenance data manual including spare parts list.

1.4 QUALITY ASSURANCE

A. Engage a factory certified installer to perform work of this Section who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance. No Exceptions.

B. The manufacturer must be a ISO 9001:2000 certified www.iso.org manufacturer with certification issued to a United States facility, this shows a commitment to delivering the highest quality service and products to the end user. Manufacturer shall be UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. All certification documents shall be provided and attached to the bid proposal. No exceptions.

C. Engage a firm experienced in manufacturing vehicle exhaust systems similar to that indicated for this Project and with a record of successful in-service performance.

D. Conduct conference at Project site. Review methods and procedures related to vehicle exhaust system installation.

1. Review access requirements for equipment delivery.
2. Review equipment storage and security requirements.
3. Inspect condition of preparatory work performed by other trades.
4. Review structural loading limitations.
5. Review that all components specified in this Section and related components specified in other Sections are accounted for.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading: Deliver components with protective packaging. Store in original protective crating and covering and in a dry location.

1.6 PROJECT/SITE CONDITIONS

A. Existing Conditions: Verify dimensions installation areas by field measurements.

1.7 COORDINATION

A. Coordinate layout and installation with other work, including light fixtures, fixed equipment and work stations, HVAC equipment, and fire-suppression system components.

B. Coordinate location and requirements of service-utility connections.

1.8 REFERENCES

A. Air Movement & Control Association International, Inc.

1. AMCA Standard 500-D-98, "Laboratory Methods of Testing Dampers for Rating".

B. ASTM International.

1. Stainless Steel:
   a. A240/A240M-04ae1 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
   b. Bright, Directional Polish: No. 4 finish.

2. Aluminum:
    a. B209/209M-04 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
    b. Powder-Coated Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.
3. Galvanized Steel:
    a. A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.9 BIDDER QUALIFICATIONS

A. Bids will only be accepted from companies that have an established reputation in the business of system design, turnkey installation and long-term service of Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than five (5) years. Bidder shall be a registered corporation, partnership or sole proprietorship within the State where the installation is to take place. Bidder must have a current and valid state contractor's license, if required by the state for the work that is being bid. Bidder shall show proof that the system specified in this Bid Document has been field tested and proven by supplying a list of references with no less than 50 fire stations with systems installed by bidder (with comparable emergency and non-emergency run rates) within a 50 mile radius of municipality seeking bid. References shall be submitted with the Bid Document and shall include phone numbers and contact names.

1.10 MANUFACTURER QUALIFICATIONS

A. Bids shall only be accepted by bidders supplying equipment from manufacturers that have an established reputation in the business of manufacturing Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than fifteen (15) years. The manufacturer must be a ISO 9001:2000 Certified in the United States www.iso.org, UL and CUL Certified www.ul.com/database/ and certified by the Air Movement and Control Association (AMCA) www.amca.org/search.htm to ensure quality, consistency and reliability of products. Certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of fifteen (15) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Air Cleaning Technologies, Inc.
The PlymoVent Corporation / PlymoVent Industrial Ventilation Systems
1300 West Detroit

Broken Arrow, Oklahoma 74012
Attn: Aaron Stewart
Telephone: (918) 251-8000
Toll Free: (800) 351-1858
FAX: (918) 251-4977
WEB: www.aircleaningtech.com E-Mail: aarons@aircleaningtech.com

2.2 EXHAUST SYSTEM GENERAL COMPONENTS

A. SUPPORT LEGS

The following is to ensure that the unit is installed as a complete system including the mounting hardware.

Support Legs: Manufactured and provided by the supplier of primary exhaust removal system (Equipment Manufacturer). Support Leg Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Supports: Standard in 19 feet lengths. A minimum of one support with appropriate bracing shall be provided for every 10 lineal feet (3 m) to 12 linear feet (3.7 m) of rail profile. The support legs shall consist of a square outer profile with dimensions no less than 2 inch (50.8 mm) OD by 0.1 inch (2.54 mm) by with 0.4 inch (10 mm) fastening hardware provided. The vertical adjustable mounting foot shall be capable of attaching the leg assembly to a ceiling with a 30-degree pitch, complete with 3/8-inch (9.5 mm) hardware necessary for mounting the leg assembly to the top suspension mount. The support leg shall be equipped with round tubular zinc-plated steel knee brace with pressed ends in standard lengths of 20 inch (508 mm), 30 inch (762 mm) and 72 inch (1828.8 mm). The angle shall be completely adjustable to the leg support and mounted perpendicular and parallel to direction of the rail. The typical support angle shall be 45 degrees from the centerline of the factory provided support leg. The standard leg shall be capable of meeting a Seismic Zone 4 requirement. Vertical support and bracing shall be provided to safely secure the rail profile in accordance with building code and seismic standards which may apply. A minimum of one support with appropriate bracing shall be provided for every 10 lineal feet (3 m) to 12 linear feet (3.7 m) of rail profile.

B. UPPER FLEXIBLE HOSE

Upper Hose: Flexible exhaust hose manufactured for the sole purpose of venting high temperature exhaust gases. Flexible Hose: Designed strictly for the harsh environment of rapid response and auto-release of a vehicle exhaust tailpipe. Hose: Range from 4 inch (101.6 mm) to 5-inch (127 mm) diameters with length of 25 feet (7.6 m) without joining or splicing connections. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a minimum overlapping thickness of 2-7/16 inches (61.9 mm). This construction of hose must be capable of operating at continuous temperatures of 400 degrees F (204 degrees C) and intermittent temperatures of 500 degrees F (260 degrees C) such as are experienced when pump checks are performed inside the station. Wire Helix: Bound and protected in laminations of hose winding. This shall be accomplished in a fashion which eliminates any possibility of personnel coming in contact with an exposed hot metal helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. Wear Strip: 9/16 inch (14.28 mm) wide and be provided as a safety yellow color. The bend radius of the high temperature hose shall be no less than 1.5 times the diameter of hose to ensure that hot gases are not restricted as they pass through the system.

C. LOWER HOSE ASSEMBLY

Lower Hose: Rigid 4 inch (100 mm) or 5 inch (125 mm) diameter by 2 ft. (610 mm) long section of yellow and black hose identical in appearance to the upper hose assembly. This construction of hose must be capable of operating at continuous temperatures of 400˚ F (204˚ C) and intermittent temperatures of 500˚ F (260˚ C) such as are experienced when pump checks are performed inside the station. **An independent third party test report shall be submitted with bid as proof of claim.** Supports the magnetic collection nozzle and stainless steel reducing elbow in a rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard. **No exceptions will be allowed.**

D. SAFETY DISCONNECT COUPLING

This coupling enables the lower two foot hose assembly to physically separate from the upper hose assembly thus reducing the possible chance of damage to system in the unlikely event the exhaust connection nozzle assembly may become entangled in the undercarriage of the vehicle. This is considered a safety requirement and any system bid must incorporate a safety disconnect. No Exceptions.

Safety Disconnect Coupling Handle (SDCH): An injection molded composite body with a 4 inch (100 mm) or 5 inch (125 mm) diameter hose connection. A 360 degree rubber bumper to protect the vehicle and disconnect from wear shall be incorporated in the design of the system. Coupling: Consists of a aluminum inner flange collar connected by a patented easy reconnect mechanism. The release tension of this device shall be preset at 84 pounds of force (375N). And easily reconnected with only 3 pounds of force (13N**)**.

E. COLLECTION NOZZLE ASSEMBLY

1. Collection Nozzle Assembly: Provides a substantially air tight seal around exhaust tail pipe when connected thus allowing for virtually 100% source capture. The seal shall limit escape of life threatening exhaust gases, which may be present during the following conditions:
   a. In the event vehicle's engine is accelerated above normal idle resulting in an exhaust velocity greater than 5000 feet per minute (25.4 meters per second).
   b. In the event that the output velocity or CFM of the exhaust exceeds the manufacturers normal capture velocity or CFM of exhaust system.

2. Magnetic Nozzle: Engineered and specially designed Patent Pending exhaust system nozzle (female connection) that is specifically designed to fit tightly over the circumference of an engineered conical mating ring (male connection) that attaches to the tail pipe and attaches tightly around the ring to capture virtually 100% of the carcinogenic diesel exhaust. Nozzle shall be typical at all drops to allow department to move apparatus from one bay to the next at any time.

3. The Stainless-reducing elbow that connects to the connection nozzle shall be fabricated using continuous welded construction. Angle of Transition: No less than or greater than 67 degrees from the centerline of the reducer. stainless Reducer: Incorporate a primary expanded metal debris screen, which is permanently affixed by welded seams to the inside, opening of exhaust fitting.

F. HOSE “SADDLE” RIGID ELBOW

Hose Suspension Saddle: Fabricated of chrome steel specifically manufactured for the sole purpose of suspending high temperature exhaust ventilation hose in a rapid response and auto-release application. The design of the saddle shall smoothly transition the direction of the hose during its travel along the track. Securing clamps shall be provided including a link fastener, for the purpose of mounting it to the balancer safety link.

G. ELECTRICAL CONTROLLERS

Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel." Individual components listed by UL - CUL shall not satisfy the above requirement. Manufacturer shall undergo monthly inspections by UL to verify all requirements and standards are met as outlined by UL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications to follow.

Electrical Controllers: Bear a visible UL listing label as proof of subscribership and shall be validated by UL www.ul.com/database/ as an "Enclosed Industrial Control Panel". Certification documents shall accompany bid documents. **No exceptions**.

1. Manufacturer Name: PLYMOVENT CORPORATION
   115 MELRICH ROAD
   CRANBURY, NJ 08512-3512
2. UL File No.: E212640
3. Electrical controller and manufacturer shall be recognized and listed by UL. Controller shall be manufactured in accordance with Underwriters Laboratories standard UL-508 for "Enclosed Industrial Control Panels". The electrical controller shall include a Class 1 limited energy con trol circuit. Enclosures shall be NEMA 12 rated and UL listed as Type 12. The electrical con trol components shall be provided and mounted in an electrical enclosure to restrict access to internal components of the controller by authorized personnel only.

Controller Performance: Designed to sense the output pressure and temperature change inside the ductwork system, which is normally generated by any internal combustion engine designed to propel a motor vehicle. The operating logic shall be designed to complete this cycle. At any point in time when a collection device is connected to a motor vehicle's exhaust tailpipe, as the operator starts the vehicle, the controller shall automatically sense the engine's output pressure or temperature of the exhaust and in turn energize the electrical contactor which will supply power to the AMCA certified spark resistant fan motor. Through the use of an adjustable timer the controller shall keep the contactors energized for up to six minutes in accordance with the stations response requirement. If the responding vehicle does not disconnect from the exhaust ventilation system in less than the designated setting, the temperature override switch shall override the time delay to ensure continuous system operation. This automated function will work for as long as the exhaust gas temperature is in excess of the setting on the heat sensor located in the ductwork system. This cycle shall not allow the electrical contactor, which energizes the exhaust fan, to short cycle or stop the fan while the system is connected to an operating vehicle.

Motor Control Contactor: Allen Bradley Industrial Electrical Contactor 100C series. The contactor shall be UL - CUL listed as an approved component.

Motor Control Overload Relay: Allen Bradley 193 ES series. Overload relay shall have an adjustable trip range to meet the proper full load amperage of the blower motor.

Soft Touch Controls: Incorporated on the face or the access door of the controller by the use of an adhesive backed Lexan membrane type label to prevent water infiltration, which would void the NEMA 12R rating. Label: Provided and secured permanently to the exterior of the electrical controller.

Label: Include the name of the manufacturer, address, telephone number, user instructions and any warnings or cautions required by Underwriters Laboratories.

1. Auto Start: This mode of operation shall be strictly for normal day use, as it would apply to receiving an emergency call and leaving the station. Any one or combination of the three devices listed below in Paragraph H shall activate the system. The system shall maintain itself in the Auto Start mode and always return there after the Stop sequence has been initiated. The controller shall not have a permanent off position due to the potential health hazards of diesel exhaust components.
2. Stop: This mode of operation shall be a system override to shut down the system manually. Up on activating this mode of operation the exhaust system blower shall shut down. After a pe riod not to exceed three seconds the controller shall automatically return to the Auto Start ready mode. This shall be a safety feature to prevent a potential health hazard from carcino genic diesel exhaust leakage from systems having an undesirable open nozzle.
3. This mode of operation shall be a system override to run the exhaust system blower continuous ly for the purpose of running the vehicles indoors for equipment checks during inclement weather. Upon activating this mode of operation the exhaust system blower shall start and run continuously until the Stop mode is activated at which point the system will automati cally return to the Auto Start ready mode within a maximum three second time period.

System Indicator LED's: Show system status at all times.

1. Auto Start Indicator: Indicate the system is in the fully automatic mode of operation and that power is on to the controller.
2. Fan On Indicator: Indicate that power is being applied to the system blower and the controller is operating normally.
3. Filter Status Indicator: Indicate, if flashing, excessive pressure loss across the filter bank media. Consequently the filter must be serviced to maintain optimum efficiency of the system.
4. Stop Indicator: Indicate the fan has been manually de-energized and will return to the Auto Start ready sequence in less than three seconds to prevent the system blower from being left in the Off mode.
5. Manual Run Indicator: Indicate the fan is operating in a continuous run mode until interrupted by the stop mode activation.

Controller Transformer: UL listed industrial control circuit transformer sized to properly supply all components so that only one transformer shall be required. Transformer shall be provided with multi-tap primary for 115, 208, 240, 277, 400, 480, and 600VAC, and 24, 120, 230VAC secondary operating on 50 or 60 hertz with a capacity of 90-volt amperes.

Control Circuit Protection: By the use of primary and secondary fuses (NEC code ref. 430-72) to meet UL requirements. The primary shall be protected by a pair of FLQ style fuses rated at 1.6 amps for voltages under 400V and a pair of .75 amp fuses for voltages over 400V. The primary fuse holder shall have a standard indicator light feature to aid in troubleshooting blown fuses. A single glass fuse rated at 3 amps at 250V shall protect the secondary side of the control circuit.

Electronic Control Circuit Card: Solid state printed circuit board. The soft controls shall be an integral part of the control circuit card. The control circuit card shall utilize a potentiometer to adjust the length of the timing cycle from 7 to 360 seconds. It shall incorporate several different modes of operation and optional features.

The controller shall be compatible with several different types of activation devices and upgradeable without the cost of replacing the whole controller. Systems connected to the apparatus electrical system and transmitting a signal while the vehicle is running will not be acceptable. Systems operating on the popular 390MHz for residential garage door operators will not be acceptable due to potential liabilities.

Activation Devices:

1. Engine Start Switch: An engine pressure sensing type, capable of recognizing the output pres sure of any type of motor vehicle exhaust. The electrical contact shall be dry type or not to ex ceed 24V ac. There shall be one sensor per vehicle.
2. Thermal Start Switch: Temperature sensing switch of the snap disc type and adjustable from 90 degrees F (32 degrees C) to 130 degrees F (55 degrees C) to configure the system based on dif ferent exhaust temperatures. There shall be one sensor per vehicle.
3. Remote Control Transmitter and Receiver: Shall be an optional feature with three independent channels of control. The receiver shall operate on 12V to 24 V AC or DC. The handheld trans mitter shall be molded out of a highly visible orange composite with a visor clip on the back making it rugged and easy to locate. It shall be powered by a 9-volt battery for ease of replace ment and cost savings. Utilizing three sets of normally open and normally closed contacts al lows the device to be used to control three separate functions from up to one quarter of a mile away.
   a. Channel A: Shall be capable of starting and stopping the exhaust system blower.
   b. Channel B: Shall be capable of operating the apparatus bay door upon entering or leaving the fire station, if desired.
   c. Channel C: Shall be capable of remotely controlling the traffic signal in front of the fire station, if so equipped.

Clean Filter Indicator Alarm: Used in conjunction with the optional Unifilter for filtering diesel exhaust particulate before release to the atmosphere. The clean filter indicator shall monitor the pressure loss across the filter bank media. Once the useful life of the filter has been depleted the pressure differential switch will signal a high-pressure loss and flash the "Fan On" indicator while the exhaust blower is running.

Electrical Wiring: Run in wire channel to allow for easier identification of the wiring circuits and for a neat appearance. All wiring circuitry shall meet International Electrical Code and UL standards for proper size, bending radiuses (International Electrical Code) and terminations.

Electrical Terminal Block: 600 V, UL rated and recognized. It shall provide individual connection points for remote controls, clean filter indicator and power connections. The primary and secondary control wiring fuses shall be incorporated into the terminal block as one unit.

Product Manual: Shall be provided with each electrical control box supplied. The product manual shall include a description of components with part numbers inclusive to the controller. It shall include a wiring schematic showing all internal circuitry as well as all field installed wiring connections to the controller.

Electrical Interference: To protect the apparatus and communications, designs that allow any possibility of electrical back-feed or induced current which may interfere with a central services communication or onboard vehicle computer logic or navigational equipment will not be accepted.

J. ELECTRICAL SYSTEM

Station Electric Supply Panel: The power circuit for the "Emergency Response Vehicle Exhaust Removal System" shall originate in a circuit breaker panel board of the appropriate size to handle the load. Fan circuit shall be supplied by a UL listed, HACR rated circuit breaker (HACR rating is specifically for motor type loads) of the same type as indicated by the manufacturer of the circuit breaker panel or a dual element time delay fuse for fuse style panels. The circuit shall be clearly marked on an engraved ledger plate or in ink on the panel schedule as "Emergency Response Vehicle Exhaust Removal System".

OS-3 Automatic Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel". Individual components listed by UL shall not satisfy the above requirement. Manufacturer must undergo

monthly inspections by UL to verify all requirements and standards are met as outlined by UL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications in 2.17 Electrical Controllers. The controller shall be mounted 6 feet (1829 mm) to the top of the cabinet AFF (above finished floor). A safety disconnecting means must be within sight of the controller for servicing and for safety reasons. If the supply panel is not within sight, a separate disconnecting means is required beside the controller (NEC code ref. 430-102 (a). Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures. See attached Table 1-1 for proper Square D part number of safety disconnect switch.

Power Wiring Conduit: Minimum of EMT utilizing compression type fittings for damp locations such as apparatus wash down areas (International Electrical Code). Conduit shall be supported with a conduit strap every 10 feet (3 m) and within 3 feet (914.4 mm) of each box or termination, (International Electrical Code and local modifiers.).

Power Wiring from Supply Panel to OS-3: THHN stranded copper wire consisting of a flame retardant, heat-resistant thermoplastic insulation with a nylon jacket for abrasion, gas, and oil resistance and rated up to 600 volts.

Low Voltage Control Wiring: Minimum of a 14/2 multi-conductor shielded cable (Anixter part number #2AS-1401POS or equivalent) to meet UL standards for the controller's low voltage field wiring. Termination procedure shall be as follows; the shielded cable shall be stripped back inside the control cabinet, the mylar foil shield and silver drain wire are to be twisted together and secured under the screw in the grounding lug inside the control cabinet. Terminations at each sensor must leave foil shielding and drain wire intact and at no point shall it come into contact with ground. There shall be only one connection to ground.

Power Wiring from OS-3 to Fan Motor: Minimum of EMT utilizing compression type fittings for damp locations such as apparatus wash down areas (NEC code ref.348-10). Conduit shall be supported with a conduit strap every 10 feet (3048 mm) and within 3 feet 914.4 mm) of each box or termination (International Electrical Code and local modifiers.). Conduit shall extend through the outside wall through a hole of the proper size and terminate directly into the back of the safety disconnect with the appropriate connector and sealed with a silicon sealer or cement mortar. (Using fan model number select appropriate wire and conduit size from Table 1-1).

Fan Safety Disconnect: Square D (or equivalent), non-fusible, NEMA 3R rated for wet locations, mounted adjacent to the AMCA Certified blower. Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures. (Using fan model number select appropriate safety disconnect from attached Table 1-1).

Liquid Tight Flexible Metal Conduit: UL listed liquid tight flexible metallic conduit (Sealtite). Conduit will encase the load wires and ground wire from the safety disconnect switch to the blower motor. Conduit length not to exceed 4 feet (1219.2 mm) from disconnect to blower motor. The appropriate listed terminal fittings shall be used. (NEC code ref.351-7) (Using fan model select appropriate conduit size from attached Table 1-1).

Spark Resistant Blower: AMCA certified, designed and installed as a direct drive spark resistant blower (IMC code ref. 503.2) The motor shall meet current EPACT standards for energy savings. Fans utilizing steel housings and impellers will not be accepted.

Temperature Switch: One for each apparatus connected to the system. The temperature switch shall be of the snap disc type and adjustable from 90 degrees F (32 degrees C) to 130 degrees F (54 degrees C). It shall be mounted on the ductwork 2 inches (50.8 mm) above the pressure switch by drilling a 1-inch (25.4 mm) hole, sealing the switch with silicon sealant and securing with 2 tek screws. Electrical connection shall be made with terminals provided or solder less type such as Thomas & Betts part no. 14RB-2577 or equivalent.

Pressure Switch: One for each apparatus connected to the system. The pressure switch shall operate at a maximum of 24VAC, pre-calibrated at .18 in. of water column. Mounting shall be accomplished by drilling a 3/8 inch (9.5 mm) hole 3 inches 76.2 mm) above the riser bracket and to the left of the regulator and threading the switch into the duct. The electrical connections shall be made with a 0.020-inch (.5 mm) by 0.187-inch (4.8 mm) female quick disconnect terminals, such as Thomas & Betts part no. 14RBD-18277 or equivalent.

OS-3 Controller Component Sizing Chart

Table 1-1

	Motor	HP	Name Plate		Circuit	Wire Size	Length of Wire in		NEC	
PlymoVen	Manuf.	Rating	Volta	gFLA	Breake	THHN	Start to Finish		Table	
Model					Size	AWG	From	To	Amps	
No. 67001	Leeson	1hp	115V	16A	30A	#14	0'	115'	16A	
						#12	116'	184'		
			230V	8A	15A	#14	0'	183'	8A	
						#12	184'	290'		
67003	Leeson	3hp	230V	17A	35A	#12	0'	215’	17A	
67005	Leeson	5hp	230V	28A	60A	#18	0'	216'	28A	
67007	Marath	7.5hp	230V	40A	80A	#8	0'	133'	40A	
						#6	134'	211'		
						#4	212'	336'		
67009	Marath	10hp	230V	50A	90A	#6	0'	167'	50A	
67012						#4	168'	266'		
67013						#3	267'	335'		
Three Phase										
67002	Leeson	1hp	208V	4.8A	15A	#14	0'	358'	4.8A	
			230V	4.2A	15A	#14	0'	352'	4.2A	
			460V	2.1 A	15A	#14	0'	1409'	2.1A	
67004	Leeson	3hp	208V	11A	20A	#12	0'	181'	11A	
			230V	9.6A	20A	#12	0'	223'	9.6A	
			460V	4.8A	15A	#14	0'	563'	4.8A	
67006	Leeson	5hp	208V	17.5 A	35A	#10	0'	187'	17.5A	
						#8	188'	298'		
			230V	15.2 A	30A	#10	0'	229'	15.2A	
			460V	7.6A	15A	#14	0'	362'	7.6A	
67008	Leeson	7.5hp	208V	25.3 A	50A	#10	0'	145'	25.3A	
						#8	146'	231'		
						#6	232'	366'		
			230V	22A	45A	#10	0'	174'	22A	
						#8	175'	278'		
			460V	11A	20A	#14	0'	275'	11A	
						#12	276'	437'		
67010	Leeson	10hp	208V	32.2 A	60A	#8	0'	178'	32.2A	
67011						#6	179'	282'		
			230V	28A	60A	#8	0'	215'	28A	

						#6	216'	340'		
			460V	14A	20A	#12	0'	338'	14A	
67014	Leeson	15hp	208V	48.3 A	90A	#6	0'	190'	48.3A	
						#4	191'	303'		
			230V	42A	80A	#6	0'	231'	42A	
						#4	232'	369'		
			460V	21A	40A	#10	0'	365'	21A	

Manufacturer assumes no liability for any electric installation; all local, city, and the National Electric Code must be followed. This chart was calculated for a maximum voltage drop of 3% and is to be used as a guideline.

K. AIR MOVING DEVICES

Centrifugal Fans: Direct drive centrifugal type, high pressure, single width, and single inlet as required or indicated. Impeller Wheels: Backward inlcline design for high static pressure performance, spark resistance and made of Aluminum. The impeller shall be dynamically and statically balanced and of the non-overloading type to provide maximum efficiency while achieving quiet, vibration-free operation. The fan housing shall be manufactured from aluminum AA-1050A material or equivalent with an aluminum, finish. The outlet configuration shall be top horizontal, bottom horizontal, or upblast. The housing shall be capable of field reconfiguration in the event the mounting position needs to be changed for unforeseen reasons.

Fan Motor and Bearing: All 1 horsepower (746 watts) to 15 horsepower (11190 watts) motors shall be totally enclosed fan cooled (TEFC) continuous duty rated. The motors shall be dual voltage where applicable. Motors built after October 27th, 1997 shall comply with the government mandated "Energy Policy and Conservation Act" (EPACT) as outlined by the Department of Energy. The bearings shall be self-aligned, ball bearing type permanently sealed and lubricated. The exhaust discharge outlet shall be in compliance with International Mechanical Code and ACGIH recommendations (min. of 36" above roofline). Air intakes, windows, cascade systems, prevailing currents, communication equipment and building aesthetics shall be considered in the final location of the fan.

1. Teflon Shaft Seal: The fan shaft shall be steel and rotate in a non-sparking TEFLON seal to prevent leakage and to prevent hot exhaust gases from coming into contact with the motor bearings.
2. Variable Speed Drive: The motor shall be compatible with a variable speed drive unit.

Performance: The delivered volume shall take into account all the static regain of vehicle engine exhaust (based on an airtight connection at the tailpipe), lengths of ductwork, elbows, branches, shut off, wyes, etc. which accumulate the static pressure at the field inlet. The manufacturer's provided fan(s) shall be performance guaranteed.

1. Fan Capacity: The Fan Capacity shall be sized as such as to deliver the required CFM at each hose drop to which the vehicle is attached.
   a. The 4-inch (101.6 mm) hose system shall be designed to deliver a minimum of 500 CFM (2.9 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.
   b. The 5-inch (127 mm) hose system shall be designed to deliver a minimum of 750 CFM (4.4 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.
   c. The 6-inch (152.4 mm) system shall be designed to deliver a minimum of 1100 CFM (6.4 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

Location: The preferable fan location shall be on the outside of the fire station as far away from

any living quarters as possible so that firefighters would not be disturbed by the system activation. No blower fans shall be mounted inside the fire station.

L. DUCTWORK SYSTEM

Ductwork Type and Materials:

- Interior Duct shall be Torit "Easy Duct" system galvanized construction.
- Exterior Duct shall be Torit "Easy Duct" system galvanized construction.

Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 10 inches (254 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches water gauge (1990 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101.6 mm) through 11 inches (279.4 mm) diameter shall be 22-gauge standard pipe (International Mechanical Code).

Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degree (International Mechanical Code). All Seams: Continuous stitch welded and if necessary internally sealed to ensure air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 20 gauge-galvanized steel and constructed as two-piece with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where airflow is introduced to the transport duct manifold.

A. Ductwork Design Velocities: Minimum of 3500 FPM (20.3 M/Second) to 4000 FPM (23.2 M/Second) transport velocity. Capture Velocity: 5500 FPM (31.9 M/Second) to 6000 FPM (34.8 M/Second) to extract 100 percent of the exhaust gases.

B. External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather. Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the smallest opening size.

2.3 STRAIGHT RAIL SPECIFIC COMPONENTS

A. RAIL MATERIAL

Rail Material: One-piece continuous extruded aluminum rail in a minimum length of 19 feet (5791.2 mm) in an effort to reduce the points of leakage due to seams or connections. The construction profile shall be of a round profile type, diameter of 6.5 inches (165.1 mm) with a rail thickness of 0.175 inch (4.5 mm). The bottom portion of the rail shall have a continuous slot to accept a rubber seal. Rail Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Aluminum Rail: Extruded as a one-piece design unit to maximize the structural integrity of the rail and to minimize joints. Extruded into the rail profile shall be all necessary mounting guides, which will allow for support of the rail mounting hardware and airline support cable. Mounting Channels: Provided continuously along both sides of the rail extrusion in order the proper positioning of all required mounting supports in accordance with codes. The rail shall allow the trolley/hose assembly to glide to the door threshold in a safe and effective manner.

The extruded rail channel shall allow the whole rail to remain rigid and shall provide an area to attach bolts for splicing additional rails together for systems over 19 feet (5791.2 mm) long. The overall extruded rail lengths shall be 19 foot (5791.2 mm) standard. Rail System: Equipped with a hydraulic braking system that limits travel of flex hose as the vehicle exits the building. Hydraulic Brake: Incorporated into the end cap of the suction rail.

B. TOP MOUNTING SUSPENSION

Top Mounting Suspension: Designed to attach with 2 mounting cleats to the mounting slots that were extruded into the rail profile.

C. MECHANICAL BRAKE SYSTEM

Mechanical Brake System: Incorporated into the end cap of the suction rail profile. The mechanical brake system must incorporate a pair of composite shock "bumpers" capable of reducing the forward impact of 1 to 4 suction trolleys which may be installed now or in the future to the exhaust rail system. This mechanical shock system shall be secured to a steel end cap fabricated of 6.25 inch (158.8 mm) diameter steel tubing with a wall thickness of 0.156 inch (4 mm) welded to a 0.156 inch (4 mm) steel plate with formed 90 degree side rails for rigidity. The end cap shall have a removable circular end plate to facilitate an end feed duct connection and shall be a black powder coated finish. The mechanical shock shall be capable of reducing to a full stop the trolleys in less than 4 inch (101.6 mm), without physical damage to either the rail profile or trolley that it is stopping

D. RAIL SPLICING JOINT

Rail Splicing Joint: The splice joint shall be formed aluminum extrusion equal to the internal diameter of the suction rail profile. The splice shall have a wall thickness of no less than .190 inches (4.8 m) in thickness and a length of no less than 8 inches (203.2 mm) from end to end. The rail splicing shall be safely secured by no less than 12- 3/8 inch 314.3 mm) by 1-½ inch (38.1 mm) bolts, nuts and lock washers. Each bolt shall pass through the exterior of the rail profile and splicing joint and be secured on the inside by a lock washer and nut. Self-tapping bolts or screws are not acceptable.

E. MIDDLE RAIL DUCT CONNECTION

Middle Rail Duct Connection: The rail duct connection shall be rectangular to an 8 inch diameter round transition fitting fabricated from 24 gauge galvanized steel (ASTM A653) with a double rubber U style lip seal. The rectangular slot shall be 19 inch (482.6 mm) long by 1-¾ inch (44.5 mm) high with a 3/8-inch (9.5 mm) external flange to slide into the rail profile.

F. TROLLEY ASSEMBLY

Trolley Assembly: Gantry type trolley with sealed bearing loaded wheels designed to roll inside the internal rail profile flange. The trolley chassis shall be galvanized steel (ASTM A653) epoxy coated with a black finish. The chassis shall be fitted with a tapered cone. Rubber Sealing Lips: Vulcanized Teflon strip covering 1-½ inch (38.1 mm) of the bottom edge of the sealing lip which shall minimize resistance between the cone and the rubber sealing lips. The exhaust cone transition shall be a tapered slot design which shall fit inside the suction rail profile. The tapered slot shall be equal or exceed in area the diameter of exhaust ventilation hose to which it is attached. Trolley Assembly: Equipped with rubber

impact bumpers at both the front and rear of the trolley chassis to eliminate metal-to-metal contact which could damage the trolley assembly. There shall be a system balancer assembly provided to aid in the delivery of the hose to the exit door. Balancer Assembly: Self-adjusting weight spring tension balancer with a lifting capacity of no less than 31 pounds (31 KG). The balancer shall have a minimum diameter steel cable of .080 inch (2 mm) and have a safety link connection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation is in proper condition to receive vehicle exhaust system installation.

3.3 INSTALLATION

A. Install vehicle exhaust system in accord with manufacturer’s written instructions, original design and referenced standards.

3.4 ADJUSTING

A. Adjust vehicle exhaust system for proper operation. Replace any parts that prevent the system from operating properly.

3.5 CLEANING

A. Remove all debris caused by installation of the vehicle exhaust system. Clean all exposed surfaces to as fabricated condition and appearance.

3.6 PROTECTION

A. Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

3.7 TRAINING

A. Provide training to fire department personnel in the daily use and maintenance of the vehicle exhaust removal system that has been installed and specified herein. The fire department shall be notified at least 7 days prior to the date scheduled for the training course. Training shall be for all personnel involved with the operation of the exhaust removal system to include all shifts required to man the particular facility. The Training session shall be performed in person by a recognized

representative of the manufacturer of the exhaust removal system, in addition a training video shall be provided to the fire department.

1. Provide training to all shifts during their normal shift period.

3.8 WARRANTY

A. Provide a written warranty for a period of five (5) years from date of shipment for all components including fan, motor and controls. Warranty shall be parts and labor to replace a defective part. Service shall be accomplished by a factory trained technician.

END OF SECTION 23 35 16

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Adjustable bar registers and grilles.

B. Related Sections:

1. Section 08 91 16 "Operable Wall Louvers" and Section 08 91 19 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 DIFFUSERS / GRILLES

A. Refer to schedule on plans.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Titus, Price, Krueger, Nailor

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
2. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft., acting inward or outward.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2004.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90zinc coating, mill phosphatized.

B. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

C. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, or comparable product by one of the following:

1. Greenheck
2. Cook
3. Twin City Fans

C. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.

D. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height-12 inches.

F. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.

G. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 milfor topcoat and an overall minimum dry film thickness of 2 mils.

    a. Color and Gloss: As indicated by manufacturer's designations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install gravity ventilators with clearances for service and maintenance.

C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during installation.

E. Label gravity ventilators according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Section 23 31 13 "Metal Ducts" and Section 23 31 16 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

END OF SECTION 23 37 23

SECTION 23 38 13 - COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes Type I commercial-kitchen hoods.

B. Related Requirements:
   1. Section 23 35 33 "Listed Kitchen Ventilation System Exhaust Ducts" for fire-rated ducts connecting to kitchen hoods.

1.3 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type I Hood: A hood designed for grease exhaust applications.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Standard hoods.
   2. Filters/baffles.
   3. Fire-suppression systems.
   4. Luminaires.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

   1. Shop Drawing Scale: 1/4 inch = 1 foot.

2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
5. Show water-supply and drain piping connections.
6. Show control cabinets.
7. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
8. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
9. Design Calculations: Calculate requirements for selecting seismic restraints.
10. Include diagrams for power, signal, and control wiring.
11. Duct Connections: Detail connections between ducts and hoods, including access doors and panels.
12. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

    a. Piping Diagram Scale: 1/4 inch = 1 foot.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Coordination Drawing Scale: 1/4 inch = 1 foot.
2. Suspended ceiling assembly components.
3. Structural members to which equipment will be attached.
4. Roof framing and support members for duct penetrations.
5. Items penetrating finished ceiling including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Moldings on hoods and accessory equipment.
    g. .

B. Welding certificates.

C. Field quality-control reports.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Grease Filters/Baffles: One complete set(s).

1.8 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304.
1. Minimum Thickness: 0.037 inch.
2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.

a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.

3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
4. Exposed Surfaces: ASTM A 480/A 480M, No. 3 finish (intermediate polished surface).
5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial-kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.
2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

C. Sound Dampening: NSF-certified, non-absorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

D. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.3 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets unless otherwise indicated.

J. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

K. Fabricate enclosure panels to ceiling and wall as follows:

1. Fabricate panels on all exposed side(s) with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.
2. Wall Offset Spacer: Minimum of 3 inches.
3. Wall Shelves and Overshelves: Fabricate according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," with minimum 0.0625-inch-thick, stainless-steel shelf tops.

2.4 TYPE I EXHAUST HOOD FABRICATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Denlar

B. Hood Configuration: Exhaust only.

C. Hood Style: Wall-mounted canopy.

D. Filters/Baffles: Removable, stainless-steel. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Safety for Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

E. Luminaires: Surface-mounted, LED luminaires and lamps with lenses sealed vapor tight. Wiring shall be in conduit on hood exterior. Number and location of luminaires shall provide a minimum of 70 fc at 30 inches above finished floor.

1. Light switches shall be mounted on wall adjacent to hood.
2. Luminaires: LED complying with UL 1598.

F. Hood Controls: Wall-mounting control cabinet, fabricated of stainless steel.
1. Exhaust Fan: On-off switches shall start and stop the exhaust fan. Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation.

a. Exhaust Fan Motor Starter: Comply with Section 26 29 13.03 "Manual and Magnetic Motor Controllers."
b. Exhaust Fan Motor Starter: Comply with Section 26 29 13.06 "Soft-Start Motor Controllers."

2. Exhaust Fan Interlock: Factory wire the exhaust fan starters in a single control cabinet for adjacent hoods to operate together.
3. Photocell and Temperature Control: Change speed (off, low, and high) of makeup air and exhaust-air fans with speed switch, based on temperature at hood discharge and opacity of smoke in hood. Interlock fan control with fire-suppression system to operate at high speed during fire-suppression-agent release and to remain in high-speed operation until manually stopped. Provide air-purge fan and conduit to photocell and reflector to avoid grease accumulation that will negatively affect performance of system. Controller shall limit exhaust-duct velocity of 1,500 FPM. Controller shall limit supply quantity to for proper operation of makeup air unit.
4. High-Temperature Control: Alarm shall sound and cooking equipment shall shut down before hood discharge temperature rises to actuation temperature of fire-suppression system.

2.5 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Denlar

B. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.

1. Steel Pipe, NPS 2 and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
4. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
5. Furnish electric-operated gas shutoff valve; see
6. Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.
7. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.

8. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate equipment layout and installation with adjacent Work, including luminaires, HVAC equipment, plumbing, and fire-suppression system components.

B. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in "General Hood Fabrication Requirements" Article.

C. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

D. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.

E. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners unless otherwise indicated.

F. Install hoods to operate free from vibration.

G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

J. Set initial temperatures, and calibrate sensors.

K. Set field-adjustable switches.

3.3 CONNECTIONS

A. Where installing piping adjacent to hoods, allow space for service and maintenance.

B. Install reduced-pressure backflow preventer on washer-water supply. Backflow preventer is specified in Section 22 11 19 "Domestic Water Piping Specialties."

C. Install washer-water drain piping full size of hood connection to an adjacent floor drain or a floor sink.

D. Makeup Water Connection: Comply with applicable requirements for valves and accessories on piping connections to water-cooled units in Section 22 11 19 "Domestic Water Piping Specialties."

E. Connect ducts according to requirements in Section 23 33 00 "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquid tight joint.

F. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Commercial-kitchen hoods will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial-kitchen hoods.

END OF SECTION 23 38 13

SECTION 23 41 00 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pleated panel filters.
2. Filter gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
3. Wiring Diagrams: For power, signal, and control wiring.

1.4 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.
2. Provide one container(s) of red oil for inclined manometer filter gage.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with NFPA 90A and NFPA 90B.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

B. Filter Unit Class: UL 900, Class 1.

C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.

1. Media shall be coated with an antimicrobial agent.
2. Separators shall be bonded to the media to maintain pleat configuration.
3. Welded wire grid shall be on downstream side to maintain pleat.
4. Media shall be bonded to frame to prevent air bypass.
5. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal sealed or bonded to the media.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Capacities and Characteristics:

1. Efficiency: 90 percent and greater on particles 20 micrometers and larger at 500 fpm.

2. Arrestance: 98 percent when tested according to ASHRAE 52.1.
3. MERV Rating: 13 when tested according to ASHRAE 52.2.

2.2 FILTER GAGES

A. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of the full scale range.

B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gage for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling-unit installations.

3.2 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 00

SECTION 23 51 00 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Listed double-wall vents.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Type B and BW vents.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Metal Products
2. Hart & Cooley, Inc.
3. Industrial Chimney
4. Metal-Fab, Inc.

B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a1/4-inchairspace.

D. Inner Shell: ASTM B 209, Type 1100 aluminum.

E. Outer Jacket: Aluminized steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

C. Lap joints in direction of flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 54 00 - FURNACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Gas-fired, noncondensing furnaces and accessories complete with controls.
2. Air filters.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:

1. Furnace.
2. Thermostat.
3. Air filter.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals for each of the following:

1. Furnace and accessories complete with controls.
2. Air filter.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: Five years.
b. Integrated Ignition and Blower Control Circuit Board : Five years.

PART 2 - PRODUCTS

2.1 GAS-FIRED FURNACES, NONCONDENSING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Corporation
2. Lennox Industries
3. Trane
4. JCI
5. Daikin

B. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.

C. Cabinet: Galvanized steel.

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.

D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

E. lType of Gas: Natural Gas

F. Heat Exchanger: Stainless steel.

G. Burner:

1. Gas Valve: 100 percent safety two-stage main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

H. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

I. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

J. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.

K. Vent Materials: Comply with requirements in Section 23 51 00 "Breechings, Chimneys, and Stacks" for Type B metal vents. Or as required per manufacturer.

2.2 THERMOSTATS

A. Controls shall comply with requirements in ASHRAE/IESNA 90.1, "Controls."

B. Single-Stage, Heating-Cooling Thermostat: Adjustable, heating-cooling, wall-mounting unit with fan on-automatic selector.

C. Control Wiring: Unshielded twisted-pair cabling.

1. No. 24 AWG, 100 ohm, four pair.
2. Cable Jacket Color: Blue.

2.3 AIR FILTERS

A. Disposable Filters: 1-inch thick fiberglass media in sheet metal frame.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for gas piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

C. Controls: Install thermostats at mounting height of 48 inches above floor.

D. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

3.3 CONNECTIONS

A. Gas piping installation requirements are specified in Section 23 11 26 "Facility Natural Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Section 23 51 00 "Breechings, Chimneys, and Stacks"

D. Connect ducts to furnace with flexible connector. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

E. Comply with requirements in Section 23 23 00 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

C. Measure and record airflows.

D. Verify proper operation of capacity control device.

E. After startup and performance test, lubricate bearings.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 54 00

SECTION 23 55 33.16 - GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes gas-fired unit heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For gas-fired unit heaters. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Renzor or comparable product by one of the following:

1. Sterling
2. Modine

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

C. Type of Venting: Powered vented.

D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.

E. Accessories:

1. Four-point suspension kit.

F. Heat Exchanger: Stainless steel.

G. Burner Material: Stainless steel.

H. Fuel Source: Natural Gas.

I. Propeller Unit Fan:

1. Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

J. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

K. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: Single stage.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: Differential pressure switch to verify open vent.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Thermostat: Devices and wiring are specified in Section 23 09 23.27 "Temperature Instruments."
8. Wall-Mounted Thermostat:

a. Single stage.
b. Fan on-off-automatic switch.
c. 24-V ac.
d. 50 to 90 deg F operating range.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

C. Vent Connections: Comply with Section 23 51 23 "Gas Vents."

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

B. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

END OF SECTION 23 55 33.16

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, or comparable product by one of the following:

1. Carrier
2. Trane
3. JCI

2.2 INDOOR UNITS 5 TONS OR LESS

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motors:
    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Filters: Permanent, cleanable.
8. Condensate Drain Pans:
    a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 2 inches deep.

b. Single-wall, galvanized-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
f. Mount unit-mounted disconnect switches on exterior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:

a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch deep.

b. Single-wall, stainless-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

7. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-410A.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 45 deg F.
6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and Section 23 09 93.11 "Sequence of Operations for HVAC DDC."

B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."Section 03300 "Cast-in-Place Concrete"
2. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."Section 15068 "Vibration Controls for HVAC."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 81 29 – VARIABLE REFRIGERANT VOLUME DX SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of multiple evaporator-fan and variable capacity compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.2 SUBMITTALS

A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics including:

1. Piping schematics with intended piping line lengths indicated on the drawings (piping plan to be coordinated between manufacturer and contractor prior to submittal. Generic piping schematics are not acceptable). The manufacturer shall include notes on the piping schematics indicating locations where expansion loops shall be installed.
2. Wiring schematics showing electrical connection requirements, and field control wiring terminations.
3. Field refrigerant charge volume shall be noted along with factory charge. Note schedule limitations.
4. Manufacturer's performance data shall reflect specified conditions. Nominal capacities are not acceptable. Ratings shall allow for piping lengths, scheduled ambient temperatures, etc.

B. Operation and maintenance data.

C. Contractor must have completed the manufacturer's installation training. The contractor shall submit a copy of the training completion certificate for the project manager and at least 2 pipe installers with this submittal.

D. LEED Submittals:

1. Credit EA 4: Manufacturers' product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

1.3 QUALITY ASSURANCE

A. The units shall be listed by the Electrical Laboratories (ETL) and bear the cETL label.

B. All wiring shall be in accordance with the National Electric Code (NEC).

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings." Provide certified efficiency ratings per AHRI-1230 standard. (DOE Waiver is not acceptable) Scheduled EER and IEER ratings scheduled shall be considered minimum efficiency allowed.

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings." Provide certified efficiency ratings per AHRI-1230 standard. (DOE Waiver is not acceptable) Scheduled COP ratings scheduled shall be considered minimum efficiency allowed.

E. Units shall be designed to operate with HCFC-free refrigerants.

1.4 WARRANTY

A. All VRF equipment and controls shall be warranted by the manufacturer for a period of 10 years from the date of startup. (Startup not to exceed 6 months from delivery). The warranty shall include both parts only. The system shall have a labor warranty for 1 year including refrigerant.

B. All warranty shall be executed by the manufacturer's authorized representative. Contractor warranty shall not be allowed.

C. Copies of the warranty paperwork and startup documentation shall be submitted upon close out of the installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin AC
2. Mitsubishi

2.2 GENERAL DESCRIPTION

A. The variable capacity, heat recovery and/or heat pump air conditioning system shall be a Variable Refrigerant Volume (heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, manufacturer

supplied refrigerant joints and headers, a two or three pipe refrigeration distribution system using PID control, and matched variable speed outdoor condensing units. The outdoor unit is a direct expansion (DX), air-cooled heat recovery/heat pump, multi-zone air-conditioning system with variable speed driven compressors using R-410A refrigerant. All zones are each capable of operating separately with individual temperature control.

B. Where heat recovery is specified, operation of the system shall permit either individual cooling or heating of each fan coil simultaneously or all of the fan coil units associated with one branch cool/heat selector box. See drawings for Branch Selector locations and associated fan coil units.

C. Branch selector (BS) boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 96 MBH (cooling) down stream of the BS box. The BS box shall consist of five electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the BS box and main processor and between the BS box and fan coils. The BS box shall control the operational mode of the subordinate fan coils. The use of five EXV's ensures continuous heating during defrost, no heating impact during changeover and reduced sound levels. If solenoid valves in the selector box cause a "clicking" sound upon changeover, then the contractor shall be required to provide additional acoustic wrapping of the box until sound levels are acceptable to the owner and engineer.

D. The indoor units shall be connected to the condensing unit utilizing manufacturer specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable. All joints shall be installed per manufacturer's instructions.

E. Equipment capacities to meet leaving air temperatures (LAT) and Total and Sensible capacities as scheduled.

2.3 EVAPORATOR-FAN UNIT – DUCTLESS CASSETTE

A. Ceiling cassette fan coil units shall be equipped with an electronic expansion valve for installation into the ceiling cavity. It shall be a round flow air distribution type. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition.

B. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

C. Return air shall be through the concentric panel, which includes a resin net, mold resistant, antibacterial filter.

D. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 20" of lift and has a built in safety shutoff and alarm.

E. Units shall be equipped with a return air thermistor.

F. Units shall utilize a factory mounted occupancy sensor. The occupancy sensor shall enable a setpoint reset function for energy savings by allowing the school district to change the setpoint based on both occupied and unoccupied times. This requirement shall be by the VRF equipment provider and not by BAS.

2.4 WALL MOUNTED FAN COIL UNIT

A. General: indoor unit shall be a wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

B. Performance: Each unit's performance is per the scheduled capacities.

C. Indoor Unit:

1. The indoor unit shall be factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through a resin net mold resistant filter.
5. The indoor units shall be equipped with a condensate pan.
6. The indoor units shall be equipped with a return air thermistor.
7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
8. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.
4. A thermistor will be located on the liquid and gas line.
5. A condensate pan shall be located in the unit.

2.5 AIR-COOLED VARIABLE REFRIGERANT VOLUME CONDENSING UNIT

A. Outdoor units shall be provided for either 460/3/60 or 230/3/60 as scheduled.

B. VFD Inverter Control – Each condensing unit shall use a high efficiency, variable speed "inverter" compressor coupled with inverter fan motors for superior part load performance. Compressor capacity shall be modulated automatically to maintain constant suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads.

C. Systems shall use a field installed 16 or 18 AWG, 2-wire, stranded, non-shielded and non-polarized daisy chain control wiring to interconnect the condensing units, branch selectors, and fan coil units.

D. Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.

E. Condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, and refrigerant regulator.

F. Units shall be capable of operating down to zero degree F ambient air.

G. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

H. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

I. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed milled steel panels coated with a baked enamel finish.

J. Condenser fan shall be direct drive motors that have multiple speed operation via a DC (digitally commutating) inverter.

K. CONDENSER COIL:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

L. COMPRESSOR:

1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G2-type" with a maximum speed of 7,980 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 4% to 100%.
5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

2.6 BRANCH SELECTOR BOXES (HEAT RECOVERY SYSTEMS)

A. ISOLATION VALVES - Full port, bi-directional flow isolation valves shall be installed upstream of all Branch Selector boxes. Where multi-port boxes are used, provide isolation valves both upstream and downstream of the box to facilitate isolation of individual fan coil units. Ensure Schrader fitting is positioned on the downstream side of the valve.

B. Where heat pump systems are used, provide isolation valves at the fan coils.

C. During simultaneous heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

D. CONSTRUCTION:

1. The Branch Selector boxes shall have a galvanized sheet plate casing.
2. Each Branch Selector shall house 5 electronic expansion valves for refrigerant control. (Multi-port boxes shall maintain independent EEV construction. Sharing of valves between zones is not allowed)
3. Where multiple boxes are installed on the same system, the piping shall be such that isolation of one box shall not disrupt refrigerant flow to other boxes. “Pass through” of refrigerant should not be used where isolation for service will prevent usage of other zones.
4. The cabinet shall contain a subcooling heat exchanger.
5. The unit shall have a sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
6. All pipe connections shall be brazed type.
7. Branch Selectors shall not require condensate drains.

E. ELECTRICAL:

1. The unit electrical power shall be 208-230 Volt, 1 phase, 60 Hz.
2. The control voltage between the indoor and condensing unit shall be 16 Volt DC.

2.7 CONTROLS

A. ZONE CONTROLLER – Each zone/FCU shall include a 7-Day Programmable controller with the following features:

1. Backlit LCD display. Day of the week as well as time of day configurable for 12/24 hour clock shall be displayed. Display of temperature information shall be Fahrenheit. The controller shall be able to display and adjust room temperature in one degree increments.
2. The controller shall have COOL, HEAT, FAN ONLY, DRY (dehumidification), and AUTO-CHANGE-OVER modes.
3. For AUTO change over mode, the controller shall allow independent setpoints for heating and cooling to eliminate wide swings in temperature

and unnecessary change over. Independent setpoint control shall be available at both local controller and the central controller

4. Setback function shall be included with adjustable setback temperature override.
5. The programmable controller shall have the capability of individually disabling the following buttons:

    a. Menu/OK
    b. ON/OFF
    c. Mode
    d. Fan Speed
    e. Setpoint Adjustment (Up/Down Keys) (Set point adjustment shall be in 1 deg F increments)

6. The controller shall allow for a local (controller-level) adjustable limitation of user setpoint range.
7. SCHEDULING: (Schedules shall be controlled via the BAS Interface - See control sequence.)
8. The Remote Controller shall display error codes on the screen in the event of a system error.
9. The following Fan Coil Unit sensor values shall be available at the wall mounted remote controller:

    a. Controller thermister temp
    b. (Refrigerant) Liquid line temperature
    c. (Refrigerant) Gas line temperature

10. 48 Hour battery back up of clock/date. All other settings shall be stored in non-volatile memory to ensure that settings are not lost upon power failure.

B. CENTRAL CONTROLLER

1. The building shall be installed with a web-enabled factory native central controller. The manufacturer native controller shall provide web users to manipulate the following functions:

    a. On/Off Control
    b. Schedule-Adjustment (schedules to be maintained by BAS)
    c. Mode Selection – See control sequence for heat/cool changeover control
    d. Setpoint Control (Independent heating and cooling setpoints available)
    e. Operational Status and Alarm Notifications
    f. Provide with battery backup and USB port for software updates
    g. User and Administrator Levels with password protection.
    h. Customize groups and zones

C. CONTROL SEQUENCE:

The VRF system shall be provided with required hardware and software to perform the core operational sequences detailed in this section.

1. The VRF central controller shall be provided onsite as a touch screen panel located as shown on the plans. It shall additionally be capable of being accessed to the internet via an owner provided IP address and Ethernet connection. All functions detailed below shall be available via touch screen interface and internet access.
2. Display interface: The controller shall provide a floor plan layout of the building with the fan coil icons and temperature information visible on the screen. At commissioning, the fan coil units shall have the tagging updated to provide the applicable room numbers for the as-built installation. The visual interface shall provide clear indication of what fan coil units are connected to which particular condensing unit system.
3. The controller shall combine all indoor units onto a single central controller interface. The central controller shall provide these basic functions per zone:

    a. Alarm Identification per fan coil unit
    b. Min/Max set point limiting

        1) Heating set point and cooling set points shall be controlled individually
        2) Set points shall be adjustable at the zone level with adjustable limits controlled by the VRF central controller (initial programming shall limit cooling setpoint control to between 73 – 76 deg. Heating initial range to be 69 – 72 deg)

    c. Timed override for after-hours air conditioning: During periods where the building is not in use the fan coil units shall be capable of being turned on at the wall mounted controller. The VRF system shall automatically turn off after 60 minutes (adj) of operation.

4. Heat/Cool Automatic Changeover Sequence:

    a. The VRF manufacturer's controller shall manage the heat/cool changeover automatically. The local thermostat MODE button shall be disabled by VRF central controller.
    b. For systems where multiple fan coils are connected to a common heat pump condensing unit the central controller shall be capable of monitoring room temperature in each space and make a central change over based on a weighted average of room temperatures or a fixed min/max point with either heat or cool as priority.
    c. Requirement of manual change-over of heat/cool mode is not acceptable.
    d. Each zone/fan coil unit shall have minor set point adjustment per the zone controller detail above. The central VRF controller shall monitor each fan coil unit connected to the heat pump condensing unit and compare the current temperature to the unit's set point. The

central controller shall make the heat/cool mode changes for the group of fan coils based on the weighted average of their demand.

1) Example – All zones are satisfied (system idle) and the system has heating mode enabled. Any fan coil on the system that has a space temperature rise above the active set point will result in a central enabling of the cooling mode.
2) Individual fan coil units (or groups) should be capable of being assigned a higher priority if directed. This would allow heating/cooling needs of these units to drive the heat/cool mode changes.

5. Exhaust fan integration. Where noted on the plan drawings, the VRF central controller shall be provided with applicable I/O expansion hardware in order to schedule the exhaust fans through the central controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mechanical contractor must complete an accredited installation training class prior to starting the installation. The contractors PM and piping foreman must each have certification.

B. Installation shall be per manufacturer's recommendations. Extra care shall be provided to allow for expansion and contraction of piping. Contractor shall install expansion joints on gas lines per the manufacturer's recommendations.

C. UNDER NO CIRCUMSTANCE SHALL THE FAN COIL UNITS BE OPERATED BEFORE STARTUP OR WITHOUT SPECIFIED FILTERS IN PLACE.

3.2 FIELD QUALITY CONTROL

A. The installing contractor shall complete the installation and complete a total system pressure test of 550 psi for 24 hours prior to startup.

B. The manufacturer's agent shall provide training and assistance to the installing contractor and confirm that the manufacturer's commissioning procedures are followed:

1. Evacuation of the piping system to a 500 micron vacuum (hold 3 hours)
2. Proper charging of the system with R-410A **(Refrigerant provided and installed by the installing contractor)**
3. Execution of all standard diagnostics.

4. Connection to the system with the manufacturer's Service Checker software and creating an operational log of the following information for verification:

    a. Each system operates with proper temperatures, delta T and superheat conditions in both cooling and heating modes.
    b. Each fan coil unit is heating/cooling properly (verification that piping work has been installed properly.

    5. A digital copy of these operational logs shall be stored by the manufacturer's agent as well as delivered to the owner with warranty documentation.

END OF SECTION 23 81 29

SECTION 23 82 39.19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berko
2. Chromalox
3. Markel

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Controls: Unit-mounted thermostat.

B. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall unit heaters to comply with NFPA 90A.

B. Install wall unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 39.19

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
2. Section 27 15 00 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire or comparable product by one of the following:

1. Alpha Wire Company.
2. Southwire Company.
3. Thomas & Betts Corporation; A Member of the ABB Group.

C. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for, Type THHN-2-THWN-2,.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbel Power Systems or comparable product by one of the following:

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Multimode optical-fiber cabling.
2. UTP cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with eggshell latex paint. Comply with requirements in Section 09 91 23 "Interior Painting."

2.4 OPTICAL-FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

C. Description: Multimode, 62.5/125-micrometer, 24-fiber, nonconductive, tight-buffer, optical-fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAB-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
    a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
    b. Plenum Rated, Conductive: Type OFCP, or Type OFNP in listed plenum communications raceway.
5. Conductive cable shall be aluminum-armored type.
6. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

D. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL-FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 36-inchlengths.

E. Cable Connecting Hardware:

1. Comply with Optical-Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA-568-C.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss of not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.6 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

C. Description: 100-ohm, four-pair UTP, 25-pair UTP covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.
2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.
3. Comply with TIA-568-C.1 for performance specifications.
4. Comply with TIA-568-C.2, Category 6.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NEMA WC 66, and UL 444 NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.7 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

D. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

H. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

I. Workstation Outlets: Two-port-connector assemblies mounted in single faceplate.

J. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical-fiber, and coaxial work area cords.

a. Flush-mounted jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Factory labeled by silk-screening or engraving stainless steel faceplates.
2. Machine printed, in the field, using adhesive-tape label.
3. Snap-in, clear-label covers and machine-printed paper inserts.

2.8 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.9 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.10 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Service Wire or comparable product by one of the following:

1. General Cable; General Cable Corporation.
2. Southwire Company.

C. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

D. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

E. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

F. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables according to TIA-568-C.2.

C. Factory test optical-fiber cables according to TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test optical-fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set.
2. Test optical-fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inchdimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
10. Support: Do not allow cables to lay on removable ceiling tiles.

11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 27 15 00 "Communications Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

E. Optical-Fiber Cable Installation:

1. Comply with TIA-568-C.3.
2. Terminate cable on connecting hardware that is rack or cabinet mounted.

F. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords

and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical-Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
      2) Attenuation test results for links shall be less than 2.0 dB.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 05 23

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Thomas & Betts or comparable product by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. O-Z/Gedney; a brand of Emerson Industrial Automation.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inchholes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

F. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange.

Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other

than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Substations and Pad-Mounted Equipment: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 26 05 48.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit; a part of Atkore International.
    b. B-line, an Eaton business.
    c. ERICO International Corporation.
    d. G-Strut.
    e. Thomas & Betts Corporation; A Member of the ABB Group; Metal Framing Channels.
    f. Unistrut; Part of Atkore International.

3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit; a part of Atkore International.
    b. B-line, an Eaton business.
    c. G-Strut.
    d. Haydon Corporation.

3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
4. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
5. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and

shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inchin diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 13 "Exterior Painting", Section 09 91 23 "Interior Painting", and Section 09 96 00 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 27 05 28 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 28 05 28 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. O-Z/Gedney; a brand of Emerson Industrial Automation.
4. Thomas & Betts Corporation; A Member of the ABB Group.
5. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel or aluminum.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

    a. Material: Steel.
    b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems; a part of Atkore International.
2. Niedax Inc.
3. RACO; Hubbell.
4. Thomas & Betts Corporation; A Member of the ABB Group; ENT Flexible Raceway.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Flanged-and-gasketed type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.

J. Gangable boxes are prohibited.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: GRC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inchtrade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close

to slab support. Secure raceways to reinforcement at maximum 10-footintervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inchtrade size and insulated throat metal bushings on 1-1/2-inchtrade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inchtrade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:

1. Install surface raceway with a minimum 2-inchradius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg. F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC [**and EMT**] conduit that is located where environmental temperature change may exceed 100 deg. F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg. F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg. F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg. F temperature change.
    d. Attics: 135 deg. F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg. F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Locate boxes so that cover or plate will not span different building finishes.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inchannular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inchannular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings,

Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,-.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,-.

C. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.

4. Weight: 28 lb/1000 sq. ft..
5. 3-InchTensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.7 INSTRUCTION SIGNS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.9 CABLE TIES

A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 30-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 203/110-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 403/117-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inchesfrom terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Emergency system boxes and enclosures.
e. Enclosed switches.
f. Enclosed circuit breakers.
g. Enclosed controllers.
h. Variable-speed controllers.
i. Push-button stations.
j. Contactors.
k. Remote-controlled switches, dimmer modules, and control devices.
l. Battery-inverter units.
m. Power-generating units.
n. Monitoring and control equipment.
o. UPS equipment.
p. Receptacles, lighting switches and junction boxes (type written label with panel and circuit number)

END OF SECTION 26 05 53

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Medium-voltage controller.
3. Motor-control center.
4. Distribution panelboard.
5. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.

e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141 IEEE 241 IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 05 73

SECTION 26 05 73.19 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Specialist.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

B. Operation and Maintenance Procedures: In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

F. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.

8. Recommendations for arc-flash energy reduction.

G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Motor-control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.

3.3 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.4 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.

3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
12. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.5 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Control panel.

3.6 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.7 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 05 73.19

SECTION 26 0918 - REMOTE CONTROL SWITCHING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Networked switching controls.

B. Programmable switching controls.

C. Remote control switching relays.

D. Remote switches.

E. Remote sensors.

F. Power supplies.

G. Relay cabinets.

1.2 RELATED REQUIREMENTS

A. Section 26 0534 - Conduit.

B. Section 26 0537 - Boxes: Switch outlets and installation of switch devices.

C. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.

D. Section 26 2416 - Panelboards.

1.3 REFERENCE STANDARDS

A. NEMA ICS 4 - Application Guideline for Terminal Blocks; National Electrical Manufacturers Association; 2015.

B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements and 26 0200 - Basic Electrical Requirements, for submittal procedures.

B. Prior Approval: If products from other than the named manufacturer are submitted in consideration for inclusion within the project, all of the following requirements must be met. Failure to meet any one of the following requirements will constitute failure to comply with the project requirements and the submitted package will not be considered for inclusion.

1. Specifications Compliance: Submit a line-by-line comparison that describes the differences between each specifications requirement and the equipment / systems being proposed. Comparison shall include a complete listing of how the proposed equipment / systems differ from that specified with regard to size, quantity, quality, method of control, features and functions, control software functions and installation requirements.
2. System Description: Supply as part of the submittal package a brief description of the lighting control system’s major features and functions.

3. Bill of Materials: Provide as part of the submittal package a detailed itemized listing, using the Engineer’s project naming convention, of all proposed equipment, including quantities and capacities for all major system components.
4. Product Data Sheets: Provide as part of the submittal package, detailed product data sheets, using the engineer’s project naming convention, providing one individual product data sheet per each specified component, for all major system components.
5. Warranty: Provide as part of the submittal package a complete written warranty.
6. One-Line Diagram: Provide a one-line diagram showing all relay lighting control panels and devices connected to the lighting control system such as master relay panel, satellite relay panel(s), digital time clock, low voltage switches, bus boosters, network connectors, typical interconnection diagrams, etc.
7. Lighting Controls Layouts: Provide lighting controls equipment and device layouts in *.pdf format, on the Architect's most current ceiling plans, using the same scale and text height as the engineering ceiling plans, for all spaces with location and model number of each device and system component clearly indicated in all spaces for evaluation of conformance to the design intent by the Engineer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on construction, dimensions, ratings, finishes, features, mounting requirements, listings, service condition requirements, installed accessories, and stardard wiring diagrams; include model number nomenclature clearly marked with all proposed features. Provide separate product data information for each lighting control device indicated using Engineer's project naming convention.
   1. Provide submittals for this Section concurrently with Sections 26 0923, 26 5100 and 26 5600.
   2. Arrange in order of device designation.

D. One-Line Diagram: Provide a one-line diagram showing all relay lighting control panels and devices connected to the lighting control system such as master relay panel, satellite relay panel(s), digital time clock, low voltage switches, bus boosters, network connectors, typical interconnection diagrams, etc.

E. Lighting Controls Layouts: Provide lighting controls equipment and device layouts in *.pdf format, on the Architect's most current ceiling plans, using the same scale and text height as the engineering ceiling plans, for all spaces with location and model number of each device and system component clearly indicated in all spaces.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. Project Record Documents: Record actual locations of components and record circuiting and switching arrangements.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 NETWORKED LIGHTING CONTROL

A. Description: Distributed switching control using networking programmable relay panels, with central computer for operator interface, programming control sequences, and monitoring.

B. Central Computer: verify software requirements and if the BAS central computer is capable of supporting the lighting control software, then install on the BAS central computer. If the BAS central computer is not capable of supporting the lighting control software, coordinate the purchase of a central computer with the local manufacturer's rep.

C. Software Features:
   1. Security: Password protection for accessing and modifying data.
   2. Data Protection: Full data backup capability.
   3. Operating Schedules: Capacity of 12 for each programmable relay panel and 12 system wide time schedules. System-wide schedules adjust relay panel schedules globally.
   4. Programming: Available from central computer and downloaded to individual programmable relay panels.
   5. Diagnostics: Include diagnostic and testing procedures to enable troubleshooting.
   6. Maintenance Data: Track runtime in minutes and relay operation in cycles.
   7. Warning Flicker: Flash lights 5 minutes before shutting down.
   8. Time Delay: Allow adjustable time delay between scheduled ON-OFF and operation of individual relay.
   9. Egress and Common Area Links: Operate identified relays ON when other circuits in common area are energized; allow adjustable time delay after other circuits de-energize before operating identified relays OFF.

D. Networking Hardware and Software: Support 2-wire communications between programmable relay panels, allow global switching and telephone control, and include RS-232 serial data port for connecting central computer.

2.2 PROGRAMMABLE RELAY PANELS

A. Description: Relay cabinet with power supply, terminal blocks, and logic cards for the specified programming functions.

B. Relays per Panel: As indicated on drawings.

C. Programming Functions:
   1. Multiple Switch Control: More than 1 switch can control each relay.
   2. Relay Grouping: Allow relays to be grouped for common control.

D. Cabinet: Surface-mounted sheet metal cabinet.

2.3 REMOTE CONTROL SWITCHING RELAYS

A. Description: Heavy duty, two-coil momentary contact type remote control relays.

B. Contacts: Rated 20 amperes at 277 volts and with isolated and non-isolated pilot contacts where indicated.

C. Line Voltage Connections: Clamp type screw terminals.

2.4 REMOTE SWITCHES

A. Wall Switch: push-button type as indicated on drawings.

B. Switch Plates:
   1. Description: Smooth plastic, Color by Architect.

2.5 REMOTE SENSORS

A. Exterior Lighting Sensor:
   1. Description: Photodiode lighting sensor in weatherproof housing.

B. Interior Lighting Sensor:
   1. Description: Photodiode lighting sensor suitable for mounting on wall or ceiling and characterized with a dead band to eliminate ON-OFF cycling of relays in response to its own switching action.

C. Skylight Lighting Sensor:
   1. Description: Photodiode lighting sensor suitable for measuring direct daylight and characterized with an averaging function.

D. Atrium Lighting Sensor:
   1. Description: Photodiode lighting sensor suitable for averaging ceiling brightness.

E. Photocell Control Unit:
   1. Photodiode control unit with PHOTOCELL ENABLE and MASTER OVERRIDE inputs for remote control, 3-minute time delay.
   2. Selectable ranges for 1 to 10 fc, 10 to 100 fc, 100 to 1000 fc, 1000 to 10,000 fc.

2.6 RELAY CABINETS

A. Interior Panel: Metal, suitable for mounting components, matte white.

B. Metal Barriers: Between wiring of different systems and voltages.

C. Power Terminals: NEMA ICS 4, unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: NEMA ICS 4, modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

E. Ground Bus Terminal Block: Bond each connector to enclosure.

F. Plastic Raceway:
   1. Description: Plastic channel with hinged or snap-on cover.

G. Power Supply: NFPA 70, Class 2 transformer.

2.7 POWER LIMITED WIRE AND CABLE

A. Remote Control Cable: Copper conductor, 300 volt insulation rated 60 degrees C, individual conductors twisted together and covered with PVC jacket.

B. Plenum Cable: Copper conductor, 300 volt insulation rated 60 degrees C, individual conductors twisted together and covered with nonmetallic jacket; suitable for use in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install wiring in conduit in accordance with Section 26 0534.

B. Install relays to be accessible. Allow space for adequate ventilation and circulation of air.

3.2 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of system.

END OF SECTION

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors.

B. Outdoor motion sensors.

C. Time switches.

D. In-wall time switches.

E. In-wall interval timers.

F. Outdoor photo controls.

G. Daylighting controls.

1.2 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0537 - Boxes.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 0918 - Remote Control Switching Devices: Remotely controlled devices for lighting control, including networked lighting controls, programmable relay panels, and remote control switching relays.

E. Section 26 2726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

1. Includes finish requirements for wall controls specified in this section.

2. Includes accessory receptacles, switches, dimmers and wall plates, to match lighting controls specified in this section.

F. Section 26 5100 - Interior Lighting.

G. Section 26 5600 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2010.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2014.

E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 773 - Plug-in Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

G. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

H. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

I. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

J. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements and 26 0200 - Basic Electrical Requirements, for submittal procedures.

B. Prior Approval: If products from other than the named manufacturer are submitted in consideration for inclusion within the project, all of the following requirements must be met. Failure to meet any one of the following requirements will constitute failure to comply with the project requirements and the submitted package will not be considered for inclusion.

1. Specifications Compliance: Submit a line-by-line comparison that describes the differences between each specifications requirement and the equipment / systems being proposed. Comparison shall include a complete listing of how the proposed equipment / systems differ from that specified with regard to size, quantity, quality, method of control, features and functions, control software functions and installation requirements.
2. System Description: Supply as part of the submittal package a brief description of the lighting control system's major features and functions.
3. Bill of Materials: Provide as part of the submittal package a detailed itemized listing, using the Engineer's project naming convention, of all proposed equipment, including quantities and capacities for all major system components.
4. Product Data Sheets: Provide as part of the submittal package, detailed product data sheets, using the engineer's project naming convention, providing one

individual product data sheet per each specified component, for all major system components.

5. Warranty: Provide as part of the submittal package a complete written warranty.
6. One-Line Diagram: Provide a one-line diagram showing all relay lighting control panels and devices connected to the lighting control system such as master relay panel, satellite relay panel(s), digital time clock, low voltage switches, bus boosters, network connectors, typical interconnection diagrams, etc.
7. Lighting Controls Layouts: Provide lighting controls equipment and device layouts in *.pdf format, on the Architect's most current ceiling plans, using the same scale and text height as the engineering ceiling plans, for all spaces with location and model number of each device and system component clearly indicated in all spaces for evaluation of conformance to the design intent by the Engineer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on construction, dimensions, ratings, finishes, features, mounting requirements, listings, service condition requirements, installed accessories, and standard wiring diagrams; include model number nomenclature clearly marked with all proposed features. Provide separate product data information for each lighting control device indicated using Engineer's project naming convention.

1. Provide submittals for this Section concurrently with Sections 26 0918, 26 5100 and 26 5600.
2. Arrange in order of device designation.

D. One-Line Diagram: Provide a one-line diagram showing all relay lighting control panels and devices connected to the lighting control system such as master relay panel, satellite relay panel(s), digital time clock, low voltage switches, bus boosters, network connectors, typical interconnection diagrams, etc.

E. Lighting Controls Layouts: Provide lighting controls equipment and device layouts in *.pdf format, on the Architect's most current ceiling plans, using the same scale and text height as the engineering ceiling plans, for all spaces with location and model number of each device and system component clearly indicated in all spaces.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide two year manufacturer warranty for all occupancy sensors.

C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.

D. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.2 OCCUPANCY SENSORS

A. Manufacturers:

1. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:

1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
2. Sensor Technology:
   a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
   b. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
   c. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
3. Provide LED to visually indicate motion detection.
4. Operation: Unless otherwise indicated, occupancy sensor shall require a manual input to turn lighting load on, and will NOT automatically turn lighting load on when occupant presence is detected. Occupancy sensor shall turn on non-lighting loads, such as HVAC interface and controlled receptacles, when occupant presence is detected. Occupancy sensor will automatically turn all loads off when no occupant presence is detected during an adjustable turn-off delay time interval.
5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
7. Turn-Off Delay: Field adjustable, with time delay settings up to 20 minutes.
8. Sensitivity: Field adjustable.
9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
10. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above the selected level.
11. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers,

fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.

12. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.
13. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:
    a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
    b. Unless otherwise indicated or required to control the load indicated on the drawings, provide line voltage units with self-contained relay.
    c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
    d. Operation: Operates only as vacancy sensor (manual-on/automatic-off).
    e. Finish: Match finishes specified for wiring devices in Section 26 2726, "Color by Architect".
    f. Provide vandal resistant lenses for passive infrared (PIR) and dual technology wall switch occupancy sensors where indicated.
2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
3. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Wall Dimmer Occupancy Sensors:

1. General Requirements:
    a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
    b. Operation: Operates only as vacancy sensor (manual-on/automatic-off).
    c. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
    d. Finish: Match finishes specified for wiring devices in Section 26 2726, "Color by Architect".

2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
   a. Description: Low profile occupancy sensors designed for ceiling installation.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
   c. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
3. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
4. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet.

E. Directional Occupancy Sensors:

1. All Directional Occupancy Sensors: Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
   a. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
   b. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Directional Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.
   b. Long Range Sensors: Capable of detecting motion within a distance of 80 feet at a mounting height of 10 feet.
   c. High Bay Sensors: Capable of detecting motion within a distance of 50 feet at a mounting height of 30 feet.

3. Passive Infrared/Ultrasonic Dual Technology Directional Occupancy Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.

F. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on the drawings.

G. Accessories:

1. Provide heavy duty coated steel wire protective guards compatible with specified occupancy sensors where indicated.

2.3 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

1. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:

1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Provide external sliding shield for field adjustment of light level activation.
5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
6. Voltage: As required to control the load indicated on the drawings.
7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control the load indicated on the drawings.
9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

C. Locking Receptacle-Mounted Outdoor Photo Controls

1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.
8. Surge Protection: 160 joule metal oxide varistor.
9. Provide the following accessories where indicated or as required to complete installation:
    a. Receptacle: Complying with ANSI C136.10.
    b. Mounting Bracket.
    c. Shorting Cap: Suitable for replacing locking photo control to complete circuit.

2.4 DAYLIGHTING CONTROLS

A. Manufacturers:

1. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.

1. Sensor Type: Filtered silicon photo diode.
2. Sensor Range:
    a. Indoor Photo Sensors: 5 to 100 footcandles.
    b. Outdoor Photo Sensors: 5 to 250 footcandles.
    c. Atrium Photo Sensors: 200 to 2,500 footcandles.
    d. Skylight Photo Sensors: 1,000 to 6,000 footcandles.
    e. Open Loop Photo Sensors: 3 to 6,000 footcandles.
3. Finish: White unless otherwise indicated.

D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 ballasts.

E. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.

1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
2. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
3. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
4. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.
5. Output Voltage: Compatible with specified dimming ballasts.

F. Power Packs for Low Voltage Daylighting Control Modules:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
2. Input Supply Voltage: Dual rated for 120/277 V ac.
3. Load Ratings: As required to control the load indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of lighting control devices provided under this section.

1. Mounting Heights: as indicated in Section 26 2726.
2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 2726.

G. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

H. Identify lighting control devices in accordance with Section 26 0553.

I. Occupancy Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

J. Outdoor Photo Control Locations:

1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

L. Daylighting Control Photo Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for proper control of respective room or area based on manufacturer's recommendations for installed devices.
2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.

3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

M. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

N. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

O. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

P. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

Q. Where indicated or required, provide cabinet or enclosure in accordance with Section 26 0537 for mounting of lighting control device system components.

3.4 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.

G. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.

D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.

F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
3. Location: At project site.

3.8 LIGHTING CONTROLS SYSTEM OPTIMIZATION VISIT

A. Include as part of the base bid, additional costs for Lighting Control System Manufacturer (or qualified, local factory-authorized manufacturer’s representative) to visit the project site (for two days) between 3 and 6 months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit the current use of the facility. Coordinate Lighting Controls System Optimization Visit with the Owner.

B. Electrical Contractor shall record Owner's preferred lighting control personnel's contact information and submit it to the local factory-authorized manufacturer's representative for future reference.

END OF SECTION 26 09 23

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.
2. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on

translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg. F to plus 104 deg. F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance

requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include:
1. General Electric Company: GE Industrial

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 ELECTRONIC-GRADE PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include:

1. General Electric Company, GE Industrial

B. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete." Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inchcenters around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

G. Install filler plates in unused spaces.

H. Stub four 1-inchempty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inchempty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes equipment for electricity metering by utility company.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.6 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

1. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
2. Surge Protection: For main disconnect device, comply with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. Provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

END OF SECTION 26 27 13

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Communications outlets.
6. Pendant cord-connector devices.
7. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Hubbell, Leviton, Pass & Seymour

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. All devices to be Decora Style.

D. Apparatus Bay and Support Areas – all switch and outlet cover plates to be stainless steel.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 RESIDENTIAL DEVICES

A. General: All devices to be Decora Style.

B. Residential-Grade, Tamper-Resistant Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cooper; TR270.
    b. Hubbell; RR155TR.
    c. Leviton; T5320.
    d. Pass & Seymour; TR62.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.

C. Fan Speed Controls:

1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
2. Comply with UL 1917.

3. Continuously adjustable slider, 5 A.

D. Telephone Outlet:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper; 3560-6.
b. Leviton; 40649.

2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e (Verify with owner data cabling installer). Comply with UL 1863.

E. Combination TV and Telephone Outlet:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper; 3562.
b. Leviton; 40159.

2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e (Verify with owner data cabling installer). Comply with UL 1863.

2.7 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.8 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.

4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
5. Material for Apparatus Bay and support areas: stainless steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.9 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 27 15 00 "Communications Horizontal Cabling."

2.10 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle and switch with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 OZ..

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged engine-generator sets for emergency power supply with the following features:

1. Diesel engine.
2. Diesel fuel-oil system.
3. Unit-mounted control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator
6. Outdoor enclosure.
7. Vibration isolation devices

B. Related Requirements:

1. Section 26 36 00 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. EPS: Emergency power supply.

C. EPSS: Emergency power supply system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include thermal damage curve for generator.
2. Include time-current characteristic curves for generator protective device.

3. Include fuel consumption in cubic feet per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
4. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
5. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95, 80, 70, and 50 deg. F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
6. Include generator characteristics, including, but not limited to KW rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine-generator set and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.
7. Inclusion and location of recess mounted Generator Annunciator Panel (GAP) in Office 104.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Source quality-control reports, including, but not limited to the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.

7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include: Cummins

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Cummins

2. Kohler

C. Source Limitations: Obtain packaged generator sets and auxiliary components, including ATS, through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

B. UL Compliance: Comply with UL 2200.

C. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

D. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

E. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg. C.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet.

2.3 ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. EPSS Class: Engine-generator set shall be classified as a Class 2 in accordance with NFPA 110.

D. Induction Method: Naturally aspirated.

E. Governor: Adjustable isochronous, with speed sensing.

F. Emissions: Comply with EPA Tier 2 requirements.

G. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

H. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

I. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 ENGINE

A. Fuel: Diesel.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psigmaximum working pressure with coolant at 180 deg. F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Muffler/Silencer: Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 12 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 90 dBA or less.

H. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg. C regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg. F to 140 deg. F to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Piping: Fuel-oil piping shall be Schedule 40 black steel.

B. Comply with NFPA 30.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase Tank: Comply with UL 142, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
   1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of tank.
      a. Leak detector: locate in rupture basin and connect to audible and visual alarm in the event of leak.
   2. Tank Capacity: 48 hour runtime
   3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel-supply pump at 110 percent of rated capacity.
   4. Low-level alarm sensor: Liquid level device operates alarm contacts at 25 percent of normal fuel level.
   5. High-level alarm sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
   6. Piping connections: Factory installed fuel-supply and return lines, from tank to engine; local fuel fill; vent line; overflow line; and tank drain line with shutoff valve.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine-generator set battery.

E. Indicating Devices: As required by NFPA 110 for Level 1 system, including the following:

   1. AC voltmeter.

2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Current and Potential Transformers: Instrument accuracy class.

F. Protective Devices and Controls in Local Control Panel: Shutdown devices and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

1. Start-stop switch.
2. Overcrank shutdown device.
3. Overspeed shutdown device.
4. Coolant high-temperature shutdown device.
5. Coolant low-level shutdown device.
6. Low lube oil pressure shutdown device.
7. Air shutdown damper shutdown device when used.
8. Overcrank alarm.
9. Overspeed alarm.
10. Coolant high-temperature alarm.
11. Coolant low-temperature alarm.
12. Coolant low-level alarm.
13. Low lube oil pressure alarm.
14. Air shutdown damper alarm when used.
15. Lamp test.
16. Contacts for local and remote common alarm.
17. Run-Off-Auto switch.
18. Control switch not in automatic position alarm.
19. Low-starting air pressure alarm.
20. Low-starting hydraulic pressure alarm.
21. Low-fuel main tank
22. High engine temperature
23. Remote manual-stop shutdown device.
24. Battery low voltage alarm.

G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

H. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine-generator set battery.

I. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence

signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Lamp test.
17. Low cranking voltage alarm.

J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator output rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide12 lead alternator.

E. Range: Provide broad range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Drip proof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 20 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 110 MPH. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load

for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

C. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.10 MOTORS

A. Description: NEMA MG 1, Design B, medium induction random-wound, squirrel cage motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Temperature Rise: Match insulation rating.

G. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.11 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch.

B. Comply with requirements in Section 23 21 16 Hydronic Piping Specialties" for vibration isolation and flexible connectors materials for steel piping.

C. Comply with requirements in Section 23 31 13 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

D. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.12 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.13 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

D. Install packaged engine-generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

E. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Install flexible connectors and steel piping materials according to requirements in Section 23 21 16 Hydronic Piping Specialties."
2. Insulate muffler/silencer and exhaust system components according to requirements in Section 23 07 19 "HVAC Piping Insulation."
3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches clearance from combustibles.

F. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints.

G. Installation requirements for piping materials and flexible connectors are specified in Section 23 21 16 "Hydronic Piping Specialties." Copper and galvanized steel shall not be used in the fuel-oil piping system.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine-generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90 degree bend in flexible conduit routed to the generator set from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 23 05 53 "Identification for HVAC Piping and Equipment" and Section 26 05 53 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection

        1) Compare equipment nameplate data with drawings and specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify the unit is clean.

    b. Electrical and Mechanical Tests

        1) Perform insulation-resistance tests in accordance with IEEE 43.

a) Machines larger than 200 horsepower. Test duration shall be 10 minutes. Calculate polarization index.
b) Machines 200 horsepower or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Conduct performance test in accordance with NFPA 110.
6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake

and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include weekly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended

by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13

SECTION 26 33 05 - BATTERY EMERGENCY POWER SUPPLY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Emergency power supply.

B. Remote trouble alarm indicator.

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NFPA 111 - Standard on Stored Electrical Energy Emergency and Standby Power Systems; National Fire Protection Association; 2013.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog and data sheets showing electrical characteristics and connection requirements. Include unit ratings, dimensions, and finishes. Include performance data for batteries.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Maintenance Data: Include battery maintenance and unit testing procedures.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 70.

1. Maintain one copy of each document on site.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.

D. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mitsubishi Electric Automation, Inc; Model 1100A 20kVA: http://www.mitsubishicritical.com.

2.2 EMERGENCY POWER SUPPLY

A. Description: NFPA 111 Type A, Class 1.5 stored emergency power supply system designed for Level 1 applications and consisting of rectifier/charger unit, storage battery, and solid state inverter with mechanical transfer switch, in one or several enclosures. Provide unit suitable for operating HID lamps without extinguishing lamp on transfer. Provide with external maintenance by-pass switch.

2.3 RATINGS

A. Input Voltage: 208 volts, 60 Hz, three phase.

B. Output Power: 20 kVA at 0.9 power factor.

C. Output Voltage: 208 volts plus 5 percent, three phase.

D. Inverter Output Frequency: 60 Hz plus 1 percent.

E. Efficiency: 90 percent minimum.

F. Maximum Recharge Time: 12 hours following 10 minute discharge.

G. Total Harmonic Distortion: Less than 10 percent at full resistive load.

H. Battery: Lead calcium, sealed type battery.

H. Accessories: Provisions for remote battery alarm.

I. Instrumentation and Alarms: NFPA 111.

J. Charger: Dual rate, designed to maintain battery in full-charge condition during normal conditions.

2.4 REMOTE TROUBLE MONITOR

A. Instrumentation and Alarms: NFPA 111A.

B. Enclosure: surface mounted.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install units plumb and level.

C. Provide interconnection between cabinets.

3.2 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.

B. Verify operation of each unit by simulating outage.

3.3 CLOSEOUT ACTIVITIES

A. Demonstrate normal operation of unit.

END OF SECTION 26 33 05

SECTION 26 36 00 – AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

B. Related Requirements:

1. Section 26 32 13 “Engine Generators”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Manufacturer to be same as Engine Generator.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA ICS 1.

G. Comply with NFPA 70.

H. Comply with NFPA 99.

I. Comply with NFPA 110.

J. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cummins or Kohler.

2. Manufacturer to be same as Engine Generator.

2.2 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Automatic Transfer-Switch Features:

1. Under voltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under voltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V AC.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V DC minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.
    d. Exerciser Transfer Selector Switch to run one time per month on Full-Load.

2.3 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identify components according to Section 26 05 53 "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

C. ATS to be wall mounted per manufacturer’s recommendations.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Testing Agency's Tests and Inspections:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 01 79 00 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Exit signs.

D. Ballasts and drivers.

E. Lamps.

F. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 26 0537 - Boxes.

B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 26 0918 – Remote Control Switching Devices: Remote controls for lighting, including network lighting controls, programmable relay panels, and remote control switching relays.

D. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.

E. Section 26 2726 - Wiring Devices: Manual wall switches and wall dimmers.

F. Section 26 5113 - Luminaires, Ballasts, and Drivers - Lutron: Additional lighting products.

G. Section 26 5600 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; Illuminating Engineering Society; 2002 (Reaffirmed 2008).

B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.

C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; National Electrical Manufacturers Association; 2011.

H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2012.

I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 101 - Life Safety Code; National Fire Protection Association; 2015.

K. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

L. UL 1598 – Luminaires; Current Edition, Including All Revisions.

M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with the local AHJ's requirements, furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements and Section 26 0200 - Basic Electrical Requirements, for submittal procedures.

B. Prior Approval: If luminaires other than the named product are submitted in consideration for inclusion within the project, all of the following requirements must be met. Failure to meet any one of the following requirements will constitute failure to comply with the project requirements and the submitted package will not be considered for inclusion.

1. Specifications Compliance: Submit a line-by-line comparison that describes the differences between each specifications requirement and the equipment / systems being proposed. Comparison shall include a complete listing of how the proposed equipment / systems differ from that specified with regard to size, quantity, quality, method of control, features and functions, control software functions and installation requirements.

2. System Description: Where luminaires are specified with integral controls, supply as part of the submittal package a brief description of the lighting control system's major features and functions.
3. Bill of Materials: Provide as part of the submittal package a detailed itemized listing, using the Engineer's project naming convention, of all proposed equipment, including quantities and capacities for all major system components.
4. Product Data Sheets: Provide as part of the submittal package, detailed product data sheets, using the engineer's project naming convention, providing one individual product data sheet per each specified component, for all major system components.
5. Warranty: Provide as part of the submittal package a complete written warranty.
6. Photometric Calculations: Due to the difference in performance in fixtures between manufacturers, if luminaires other than the Basis of Design luminaires as indicated within the Luminaire Schedule are submitted for approval, provide in *.pdf format, ceiling plans for all spaces indicated below with the Architect's current backgrounds, using the same scale and text height as the engineering ceiling plans, with point-by-point, full radiosity illuminance calculations in a 2'x2' calculation point grid to two decimal places, electronic copy of all *.ies files with an individual *.ies file for each luminaire using the engineer's project naming convention, room or space height and/or ceiling height used in the calculations with height clearly indicated for all calculated spaces, complete interior space-by-space calculation summary table for all calculated spaces with each space name clearly indicated using Architects room number and room name separated by a hyphen, calculation plane height, light loss factor, initial lumens, and mounting height clearly indicated for all luminaires and spaces for evaluation of accuracy and conformance to the design intent by the Engineer.
    a. Provide Photometric Calculations for the following spaces: provide photometrics for all typical spaces.

C. Samples: Engineer may request the vendor provide sample(s) of lighting fixture(s) to review.

D. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

E. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features. Provide separate product data information for each luminaire indicated using Engineer's project naming convention.

1. Provide submittals for this Section concurrently with Sections 26 0923, 26 0918 and 26 5600.
2. Arrange in order of luminaire designation.
3. LED Luminaires:
    a. Include estimated useful life, calculated based on IES LM-80 test data upon request.
    b. Include IES LM-79 test report upon request.

F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.

H. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

C. Provide five year pro-rata warranty for batteries for emergency lighting units.

D. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Basis-of-Design Product: The design for each lighting fixture is based on the product as indicated in Interior Luminaire Schedule included on the drawings. Subject to compliance with requirements, provide either the named product or a comparable product as approved by the Engineer. Reference Prior Approval requirements under SUBMITTALS for luminaires other than the named basis-of-design product. All substitution requests shall be submitted 11 business days prior to bid.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
4. In Interior Luminaire Schedule, where lumens is indicated, the product shall be within 10% of the value indicated for the basis-of-design fixture.
5. In Interior Luminaire Schedule, where CCT is indicated, the product shall be within 100 K of the value indicated for the basis-of-design fixture.
6. In Interior Luminaire Schedule, where CRI is indicated, the product shall be not less than the value indicated for the basis-of-design fixture.
7. In Interior Luminaire Schedule, where Input VA is indicated, the product shall be not more than the value indicated for the basis-of-design fixture.

2.3 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated

emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:

1. Sealed maintenance-free lead calcium unless otherwise indicated.
2. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

G. Accessories:

1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
3. Provide compatible accessory wire guards where indicated.
4. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.4 EXIT SIGNS

A. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

1. Number of Faces: Single or double as indicated or as required for the installed location.
2. Directional Arrows: As indicated or as required for the installed location.

B. Self-Powered Exit Signs:

C.

1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
4. Provide low-voltage disconnect to prevent battery damage from deep discharge.
5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

D. Photoluminescent Exit Signs: Powder-coated sheet aluminum with photoluminescent pigmented material.

E. Accessories:

1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

F. Spare Materials: Provide 10% spare, but not less than 3 of each type of exit sign specified in Interior Luminaire Schedule and install in locations requiring additional exit signage as directed by the AHJ. For any spare materials that are not used, turn over to the Owner for use as attic stock.

2.5 BALLASTS AND DRIVERS

A. Ballasts - General Requirements:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

B. Dimmable LED Drivers:

1. Dimming Range: Continuous dimming from 100 percent to ten percent relative light output unless dimming capability to lower level is indicated, without flicker.
2. Control Compatibility: Fully compatible with the dimming controls to be installed.
   a. Wall Dimmers: See Section 26 2726.
   b. Daylighting Controls: See Section 26 0923.

2.6 LAMPS

A. Manufacturers:

1. General Electric Company/GE Lighting: www.gelighting.com.
2. Osram Sylvania: www.sylvania.com.
3. Philips Lighting Company: www.lighting.philips.com.
4. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.
5. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.

B. Lamps - General Requirements:

1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

2.7 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean and repair luminaires used for temporary lighting.

3.3 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.4 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.
2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
4. Secure pendant-mounted luminaires to building structure.
5. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

G. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

H. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Install canopies tight to mounting surface.
4. Unless otherwise indicated, support pendants from swivel hangers.

I. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

J. Install accessories furnished with each luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. Emergency Lighting Units:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

M. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

N. Remote Drivers: Insall in an accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire

O. Identify luminaires connected to emergency power system in accordance with Section 26 0553.

P. Install lamps in each luminaire.

Q. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 - Identification for Electrical Systems.

3.6 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.7 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.8 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.9 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.10 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 51 00

SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires.

B. Poles and accessories.

C. Luminaire accessories.

1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

C. Section 26 0537 - Boxes.

D. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.

E. Section 26 2726 - Wiring Devices: Receptacles for installation in poles.

F. Section 26 2813 - Fuses.

G. Section 26 5100 - Interior Lighting.

1.3 REFERENCE STANDARDS

A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2010.

B. ANSI O5.1 - American National Standard for Wood Poles -- Specifications and Dimensions; 2015.

C. IEEE C2 - National Electrical Safety Code; Institute of Electrical and Electronic Engineers; 2012.

D. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; Institute of Electrical and Electronic Engineers; 2002 (Cor 1, 2012).

E. IESNA LM-5 - Photometric Measurements of Area and Sports Lighting Installations; Illuminating Engineering Society; 2004 (Reaffirmed 2007).

F. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; Illuminating Engineering Society; 2002 (Reaffirmed 2008).

G. IES LM-79 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.

H. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; Illuminating Engineering Society; 2015.

I. IES RP-8 - Roadway Lighting; Illuminating Engineering Society; 2014 (ANSI/IES RP-8).

J. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

K. NECA/IESNA 501 - Recommended Practice for Installing Exterior Lighting Systems; National Electrical Contractors Association; 2006.

L. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.

M. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2012.

N. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. UL 1598 - Luminaires; Current Edition, Including All Revisions.

P. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements and Section 26 0200 - Basic Electrical Requirements, for submittal procedures.

B. Prior Approval: If luminaires other than the named product are submitted in consideration for inclusion within the project, all of the following requirements must be met. Failure to meet any one of the following requirements will constitute failure to comply with the project requirements and the submitted package will not be considered for inclusion.

1. Specifications Compliance: Submit a line-by-line comparison that describes the differences between each specifications requirement and the equipment / systems being proposed. Comparison shall include a complete listing of how the proposed equipment / systems differ from that specified with regard to size, quantity, quality, method of control, features and functions, control software functions and installation requirements.
2. System Description: Where luminaires are specified with integral controls, supply as part of the submittal package a brief description of the lighting control system's major features and functions.
3. Bill of Materials: Provide as part of the submittal package a detailed itemized listing, using the Engineer's project naming convention, of all proposed equipment, including quantities and capacities for all major system components.

4. Product Data Sheets: Provide as part of the submittal package, detailed product data sheets, using the engineer's project naming convention, providing one individual product data sheet per each specified component, for all major system components.
5. Warranty: Provide as part of the submittal package a complete written warranty.
6. Photometric Calculations: Due to the difference in performance in fixtures between manufacturers, if luminaires other than the Basis of Design luminaires as indicated within the Luminaire Schedule are submitted for approval, provide in *.pdf format, a site plan with the Architect's and Civil Engineer's current backgrounds, using the same scale and text height as the engineering site plans, with point-by-point, direct radiosity illuminance calculations in a 10'x10' calculation point grid to two decimal places, electronic copy of all *.ies files with an individual *.ies file for each luminaire using the engineer's project naming convention, complete exterior space-by-space calculation summary table for all calculation areas with each area name clearly indicated using Engineer's naming project convention, calculation plane height, light loss factor, initial lumens, and mounting height clearly indicated for all luminaires for evaluation of accuracy and conformance to the design intent by the Engineer.
    a. Provide Photometric Calculations for the following spaces: provide outdoor lighting photometrics for the entire project site.

C. Samples: Engineer may request the vendor provide sample(s) of lighting fixture(s) to review.

D. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide structural calculations for each pole proposed for substitution.

E. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.

1. Provide submittals for this Section concurrently with Sections 26 0923, 26 0918 and 26 5600.
2. Arrange in order of luminaire designation.
3. LED Luminaires:
    a. Include estimated useful life, calculated based on IES LM-80 test data.
    b. Include IES LM-79 test report upon request.
4. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

F. Delegated Design: The selected Contractor shall provide and submit to the engineer, a project specific, pole base installation detail which has been prepared and sealed by a structural engineer. The detail shall specify exact pole base dimensions, materials, ect. for all luminaires and poles provided for this project. All luminaire poles and pole bases shall be provided as required for proper structural and wind loading support within the project site wind region and soil conditions.

F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Fuses: Five percent of total quantity installed for each type, but not less than two of each type.
3. Touch-Up Paint: 2 gallons, to match color of pole finish.

H. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

C. Receive, handle, and store wood poles in accordance with ANSI O5.1.

1.8 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Basis-of-Design Product: The design for each lighting fixture is based on the product as indicated in Exterior Luminaire Schedule included on the drawings. Subject to compliance with requirements, provide either the named product or a comparable product as approved by the Engineer. Reference Prior Approval requirements under SUBMITTALS for luminaires other than the named basis-of-design product. All substitution requests shall be submitted 11 business days prior to bid.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
4. In Exterior Luminaire Schedule, where lumens is indicated, the product shall be within 10% of the value indicated for the basis-of-design fixture.
5. In Exterior Luminaire Schedule, where CCT is indicated, the product shall be within 100 K of the value indicated for the basis-of-design fixture.
6. In Exterior Luminaire Schedule, where CRI is indicated, the product shall be not less than the value indicated for the basis-of-design fixture.
7. In Exterior Luminaire Schedule, where Input VA is indicated, the product shall be not more than the value indicated for the basis-of-design fixture.

J. Exposed Hardware: Stainless steel.

2.3 POLES

A. All Poles:

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
2. Material: Steel, unless otherwise indicated.
3. Shape: Round straight, unless otherwise indicated.
4. Finish: Match luminaire finish, unless otherwise indicated.
5. Mounting Height: as indicated on the plans, unless the local authority having jurisdiction has a mounting height restriction that is lower than the height indicated on the plans, then the lower height shall take precedence.
6. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
7. Unless otherwise indicated, provide with the following features/accessories:
   a. Top cap.
   b. Handhole.
   c. Anchor bolts with leveling nuts.
   d. Anchor base cover.

e. Provision for pole-mounted weatherproof GFI receptacle where indicated.
f. Brackets.

B. Metal Poles: Provide ground lug, accessible from handhole or transformer base.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and factory-tested luminaire before shipping. Match finish process and color of pole or support materials where indicated.

C. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected from manufacturer's standard catalog of colors.

2.5 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean and repair luminaires used for temporary lighting.

3.3 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.4 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.

2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

F. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

H. Pole-Mounted Luminaires:

1. Maintain the following minimum clearances:
   a. Comply with IEEE C2.
   b. Comply with utility company requirements.
2. Foundation-Mounted Poles:
   a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 03 3000.
      1) Install anchor bolts plumb per template furnished by pole manufacturer.
      2) Position conduits to enter pole shaft.
   b. Install foundations plumb.
   c. Install poles plumb, using leveling nuts as required to adjust to plumb.
   d. Tighten anchor bolt nuts to manufacturer's recommended torque.
   e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
   f. Install anchor base covers or anchor bolt covers as indicated.
3. Grounding:
   a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
   b. Provide supplementary ground rod electrode as specified in Section 26 0526 at each pole bonded to grounding system as indicated.
4. Install separate service conductors, size as indicated on drawings, from each luminaire down to handhole for connection to branch circuit conductors.
5. Install weather resistant GFI duplex receptacle with weatherproof cover as specified in Section 26 2726 in designated poles.

I. Install accessories furnished with each luminaire.

J. Bond products and metal accessories to branch circuit equipment grounding conductor.

K. Install lamps in each luminaire.

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 - Identification for Electrical Systems.

3.7 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.8 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.9 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.10 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

D. Just prior to Substantial Completion, replace all lamps that have failed.

3.11 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 56 00

SECTION 27 42 13 – ALERTING SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, and Division 26 Specification Sections, apply to this Section.

B. Electrical Contractor responsible for coordination of all Electrical Drawing Sheets, especially Sheet E4.2 and E7.1.

1.02 SUMMARY

A. This Section includes the following:
   1. US Digital 10 Fire Station Alerting System Package (3 fixed zones)
   2. Infrastructure
   3. Conduit
   4. Wiring (cabling)
   5. Electrical boxes (or back boxes)
   6. 120 Volt, 20 amp dedicated circuit
   7. Enclosures.
   8. Radio receivers, network interface module, racks, speaker/light combos, speakers, volume controls, doorbells, acknowledge buttons, count timers, strobe lights, time clock to control exterior speakers, installation materials, testing, training, etc. for a complete and fully functional alerting system.

B. Related Sections include the following:
   1. Division 26 Electrical

1.03 SUBMITTALS

A. Product Data: Cut sheets for each product. All devices shall comply with applicable sections of NEMA Standards and NFPA 70.

B. US Digital Communications drawing package indicating US Digital system installation requirements with device locations implying coordination between US Digital and Electrical Contractor are working together to install the complete system.

C. Coordination Drawings: Reflected ceiling plans (indicating ceiling type), drawn to scale, on which the following items are shown and coordinated with each other:
   1. Back box locations and mounting heights

2. Conduit locations and indication of home runs.
3. 120 Volt, 20 amp circuit
4. Enclosure locations
5. Rack locations
6. US Digital 10 alerting system, wall and ceiling-mounted devices including all US Digital including but not limited to: speakers, time clock, ceiling access doors, strobes, volume controls, count timers, antennas, 5 paging decoders, network interface module, dual 12/24 volt Rackmount power supply, amplifier, UPS, analog overhead paging controller, radio monitor switch, etc. as necessary.
7. Minimum Drawing Scale: 1/8 inch = 1 foot

1.04 QUALITY ASSURANCE

A. Coordination between Electrical Contractor and US Digital Communications is critical. Alerting System shall be installed without additional cost to the Owner or Architect.

B. Source Limitations:
   1. Owner-Contracted with US Digital Communications. Contact: James Amos 602-887-1730

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original containers, with seals unbroken, bearing manufacturer labels indicating brand name and directions for storage.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not install wiring or devices until spaces are enclosed and weatherproofed.

1.07 COORDINATION

A. Coordinate layout and installation of alerting system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.08 WARRANTY

A. Provide one (1) year warranty from the date of signed “Testing and Acceptance”.

PART 2 - PRODUCTS

2.01 ALERTING SYSTEM

A. Products: US Digital Communications: Owner Provided, See Drawing Sheet E1.5.

2.02 ELECTRICAL CONTRACTOR INSTALLATION

A. Coordinate Drawing Sheets E1.1, E1.2 & E1.5 to provide a complete and fully functional system.

B. (1) 120vac, 20 amp dedicated circuit at FSA System HUB location.

C. 3/4" conduit where required, infrastructure, back boxes, and time clock.

D. Olympic 2890 cable (wire)

E. Alert tone sets shall be "live" at least three weeks prior to the scheduled date of installation by US Digital to facilitate system configuration and testing.

2.03 US DIGITAL COMMUNICATIONS INSTALLATION

A. Installing all devices (as listed in paragraph 2.01, A in this specification).

B. Provide and run all FSAS required wire and perform the final system and peripheral equipment hook-up and connections, and a final walk-thru test and verification of all system components and operations.

C. Coordination with Electrical Contractor and General Contractor with installation schedules, one site visit and travel plans, device installation mounting specifics, and preparation status: all customer pre-requisites are completed and prepared for US Digital personnel to arrive on site and complete the equipment installation portion of the project and final acceptance testing.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate pre-installation meeting with General Contractor and Architect prior to construction of any walls.

3.02 INSTALLATION

A. All infrastructure, conduit, wire, 120v 20amp receptacle, time clock, electrical boxes and enclosures shall be provided and installed by Electrical Contractor prior to US Digital arrival to site.

B. A minimum of ¾" conduit shall be installed throughout the facility for all hard lid ceilings to accessible areas to be run back to the FSA system. The Apparatus Bay and all exterior locations shall be weather tight as appropriate. Dorm rooms, offices or other areas that have drop or grid ceilings shall have as a minimum: a conduit path from the FSA system directly to that room or within and adjacent conduit to an accessible ceiling area within each room.

C. Local codes shall take precedence if more stringent requirements are necessary. A maximum of three (3) Olympic 3034T cables/conduit or one (1) Olympic 2890 cable per ¾" conduit when using the 10 conductor cabling.

D. US Digital Communications shall provide and install all devices plumb. Install FSAS required wire, and perform the final system and peripheral equipment hook-up and connections, with a final walk-thru test and verification of all system components and operations.

E. At the completion of the verified installation, a walk-thru shall be conducted with the Owner and Architect to verify the overall system function, performance and operation. Upon acceptable completion of the testing process, a "Testing and Acceptance" Sign-of sheet shall be signed and dated by Owner and General Contractor.

3.03 CLEANING

A. Clean all exposed surfaces from dust etc.

END OF SECTION 27 42 13

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Firefighters' two-way telephone communication service.
7. Magnetic door holders.
8. Remote annunciator.
9. Graphic annunciator.
10. Addressable interface device.
11. Digital alarm communicator transmitter.
12. Radio alarm transmitter.
13. Network communications.
14. System printer.

B. Related Requirements:

1. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
    d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified, fire-alarm technician; Level III minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.6 Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

    a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
    d. Riser diagram.
    e. Device addresses.
    f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
    g. Record copy of site-specific software.
    h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

        1) Equipment tested.
        2) Frequency of testing of installed components.
        3) Frequency of inspection of installed components.
        4) Requirements and recommendations related to results of maintenance.
        5) Manufacturer's user training manuals.

    i. Manufacturer's required maintenance related to system warranty requirements.
    j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

    1. Software operating and upgrade manuals.
    2. Program Software Backup: On magnetic media or compact disk, complete with data files.
    3. Device address list.
    4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.10 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Duct smoke detectors.
6. Carbon monoxide detectors.
7. Combustible gas detectors.
8. Automatic sprinkler system water flow.
9. Pre-action system.
10. Fire-extinguishing system operation.
11. Fire standpipe system.
12. Dry system pressure flow switch.
13. Fire pump running.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.

6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Activate pre-action system.
12. Recall elevators to primary or alternate recall floors.
13. Activate elevator power shunt trip.
14. Activate emergency lighting control.
15. Activate emergency shutoffs for gas and fuel supplies.
16. Record events in the system memory.
17. Record events by the system printer.
18. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.
5. Fire pump running.
6. Fire-pump loss of power.
7. Fire-pump power phase reversal.
8. Independent fire-detection and -suppression systems.
9. User disabling of zones or individual devices.
10. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Hose cabinet door open.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Notifier or comparable product by one of the following:

1. Gamewell - FCI by Honeywell.
2. Notifier.
3. Silent Knight.
4. SimplexGrinnell LP.

C. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.

3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

E. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two line(s) of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

F. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Install no more than 50 addressable devices on each signaling-line circuit.
3. Serial Interfaces:

a. One dedicated RS 485 port for central-station operation using point ID DACT.
b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
c. One USB port for PC configuration.
d. One RS 232 port for VESDA HLI connection.
e. One RS 232 port for voice evacuation interface.

G. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at fire-alarm control unit.
2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

H. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

I. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

    a. Elevator lobby detectors except the lobby detector on the designated floor.
    b. Smoke detector in elevator machine room.
    c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

    a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

J. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

L. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

    a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.

c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

M. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

N. Primary Power: 24-V DC obtained from 120-V AC service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V DC source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

O. Secondary Power: 24-V DC supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

P. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 PREACTION SYSTEM

A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.5 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Notifier or comparable product by one of the following:

1. Notifier.
2. Silent Knight.
3. SimplexGrinnell LP.
4. System Sensor.

C. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Notifier or comparable product by one of the following:

1. Notifier.
2. Silent Knight.
3. SimplexGrinnell LP.
4. System Sensor.

C. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for

calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg. F per minute.
b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg. F.
c. Multiple levels of detection sensitivity for each sensor.
d. Sensitivity levels based on time of day.

D. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

E. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

F. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.8 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Notifier or comparable product by one of the following:

1. Notifier.
2. Silent Knight.
3. SimplexGrinnell LP.
4. System Sensor.

C. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

D. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg. F or a rate of rise that exceeds 15 deg. F per minute unless otherwise indicated.

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide System Sensor or comparable product by one of the following:

1. SimplexGrinnell LP.
2. System Sensor.
3. Wheelock; a brand of Eaton.

C. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

D. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

F. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:

    a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.

6. Mounting Faceplate: Factory finished, white.

G. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.10 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

1. Common-talk type for firefighter use only.
2. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
3. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
4. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the fire-alarm control unit.
5. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
6. Display: Graphic to indicate location of caller.
7. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.

    a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
    b. With "break-glass" type door access lock.

8. Handsets: 2 push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit.

2.11 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbfholding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V AC or DC.
4. Rating: 120-V AC.

B. Material and Finish: Match door hardware.

2.12 GRAPHIC ANNUNCIATOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Simplex or comparable product by one of the following:

1. SimplexGrinnell LP.

C. Graphic Annunciator Panel: Mounted in an aluminum frame with nonglare, minimum 3/16-inch-thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Semi-flush mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot scale or larger.
6. The LED representing a detector shall flash two times per second while detector is an alarm.

2.13 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.14 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.15 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.16 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.

B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
3. Normal Power Input: 120-V ac.
4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
7. Antenna-Cable Connectors: Weatherproof.
8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system

outputs to message-generating inputs of the transmitter that produce required message transmissions.

C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
6. Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.17 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using BACnet for connection to building automation system.

2.18 SYSTEM PRINTER

A. Printer shall be listed and labeled as an integral part of fire-alarm system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.

2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

L. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction

B. Perform tests and inspections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form"

in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

SECTION 141200 – ELECTRIC DUMBWAITER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes power dumbwaiters and self-supporting dumbwaiter structures.

B. Related sections include the following.
   1. Division 05 Section "Cold-Formed Metal Framing."
   2. Division 09 Section "Painting."
   3. Division 09 Section "Gypsum Board."
   4. Division 26 Sections for electrical service to dumbwaiters, including disconnect switches.

1.03 PERFORMANCE REQUIREMENTS

A. Speed: 50 fpm.

B. Capacity: 300 lbs.

C. Car size: 30 inches wide by 30 inches deep by 40 inches high.

D. Doors: Bi-Parting

E. Stops: 2

F. Openings: 2 (1 at each level, same side), height as indicated on drawings.

1.04 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, Controls, finishes for dumbwaiters.

B. Shop Drawings: Include plans, elevations, sections, details and attachments to other work.

C. Samples for initial selection: For units with factory-applied color finishes.

D. Product certificates for each type of dumbwaiter, signed by product manufacturer.

E. Qualification Data: for installer.

F. Operation and Maintenance data: for dumbwaiters to include in emergency, operations and maintenance manual.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Dumbwaiter manufacturer or qualified installer approved by dumbwaiter manufacturer.

B. Regulatory Requirements: Comply with ASME A17.1 & CSA B44 Codes.

C. Fire Rated Door Assemblies: Door and frame assemblies comply with NFPA 80 that are listed and labeled by a testing and inspection agency acceptable to authorities having jurisdiction, for the fire-protection ratings indicated, based on testing at as neutral pressure as possible according to NFPA 252.
   1. Hoistway Door Rating: As indicated on drawings.
   2. Access Door Rating: As indicated on drawings.

D. Electrical Components, Devises and Accessories: Listed and labeled as defined in NFPA 70 article 100, by a testing agency acceptable to authorities having Jurisdiction and marked for intended use.

1.06 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at substantial completion, provide one year's full maintenance service by skilled employee of dumbwaiter installer. Include monthly preventive maintenance, repair or replace worn or defective components, lubrication, cleaning and adjusting as required for proper dumbwaiter operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Elevation Innovation Inc. (877) 345-4387 www.eilifts.com

2.02 MATERIALS AND COMPONENTS

A. General: Provide manufacturer's standard pre-engineered dumbwaiters. Where not otherwise indicated, provide manufacturer's products as indicated in published product literature as required for complete dumbwaiter system.

B. Systems and machinery:
   1. Driving Machine Type: Manufacturer's standard – winding drum.
   2. Hardware: Attachments required for fastening guide-rail and other dumbwaiter components to structural building framing.
   3. Machine Location: Locate dumbwaiter machine inside shaft at bottom of hoistway.
   4. Electrical Requirements: As indicated on drawings, coordinate with manufacturer's power requirements, and notify Architect immediately of any discrepancies.

C. Control system: Fully automatic allowing car to be sent or called from any floor. Terminal limit switch provided for by final. Car stop is automatic at landing levels. Door interlocks for hoistway doors to prevent operation of the dumbwaiter unless doors are closed and to prevent opening of any door except when the car is at that landing.

D. Leveling tolerance: Provide car stopping system with ½ - inch (13mm) leveling Tolerance, regardless of load or direction of travel.

E. Provide the following materials and finishes for exposed surfaces of dumbwaiter car, enclosures, car doors, hoistway doors and frames and signal equipment.
   a. Stainless Steel.

F. Car construction: Manufacturer's standard.

G. Hoistway Doors and Frames: Manufacturer's standard
   1. Frames: Stainless Steel
      a. Frames of depth and profile indicated to coordinate with hoistway wall construction.
      b. Formed metal sill members of not less than 0.0598-inch(1.5mm) thickness.
      c. Frame material: Stainless Steel
      d. Doors: Bi-Parting Stainless Steel
      e. Car Gate: Bi-Parting Stainless Steel

H. Signal Equipment: Manufacturer's standard signal equipment at each landing push-button station; include call / send button for each landing served, and illuminated "car- in-use" and arrival flashing signal.

2.03 FINISHES GENERAL

A. Comply with NAAMM's "Metal finishes manual for architectural and metal products" for recommendations for applying and designating finishes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with installer present, for compliance with requirements for hoistway installation tolerances and other conditions affecting performance at work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Alignment: Coordinate hoistway doors with dumbwaiter travel and car positioning for accurate alignment and minimum clearance between car, hoistway doors, sills, and door frame at each level.

C. Lubricate operating parts of dumbwaiter to manufacturer's recommendation.

3.03 FIELD QUALITY CONTROL

A. Test-operate dumbwaiter continuously between lowest and highest landings served, hoisting full rated capacity load for a minimum of 30 minutes. Re- adjust car tops and other devices and signal equipment for accurate landings and operation of systems after completing test.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owners maintenance personnel to operate, adjust and maintain dumbwaiters.

END OF SECTION 14 12 00

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Protecting existing vegetation to remain.
   2. Removing existing vegetation.
   3. Clearing.
   4. Stripping and stockpiling topsoil.
   5. Removing above- and below-grade site improvements.
   6. Disconnecting, capping or sealing, and removing site utilities.
   7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:
   1. Division 01 Section "Temporary Facilities and Controls."
   2. Division 01 Section "Execution."
   3. Division 02 Section "Structure Demolition."

1.03 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.05 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed photographs or videotape.
   2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.06 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

B. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.04 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
   1. Arrange with utility companies to shut off indicated utilities.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in Division 33 Sections.

3.05 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.06 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.07 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.08 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Preparing subgrades for walks, pavements, turf, and grasses and plants.
   2. Excavating and backfilling for buildings and structures.
   3. Subbase course for concrete walks and pavements.
   4. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:
   1. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
   2. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
   3. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
   4. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.03 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.04 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.

B. Samples for Verification: For the following products, in sizes indicated below:
   1. Geotextile: 12 by 12 inches.

C. Preexcavation Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.05 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section "Temporary Facilities and Controls."

C. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.

D. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Do not direct vehicle or equipment exhaust towards protection zones.

F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils:
   1. Liquid Limit: In accordance with ASTM D423.
   2. Plasticity Index: In accordance with ASTM D424.

C. Unsatisfactory Soils:
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90

percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of [washed]crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Sand: ASTM C 33; fine aggregate.

2.02 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
   3. Sewn Seam Strength: 142 lbf ;ASTM D 4632.
   4. Tear Strength: 56 lbf; ASTM D 4533.
   5. Puncture Strength: 56 lbf; ASTM D 4833.
   6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
   7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.03 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
   1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
      a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 6 inches outside of minimum required dimensions of concrete cast against grade.
      c. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      d. 6 inches beneath bottom of concrete slabs-on-grade.
      e. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.03 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.04 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.05 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.06 EXCAVATION FOR ELEVATOR CYLINDER

A. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Division 14.

B. Provide well casing as necessary to retain walls of well hole.

3.07 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.08 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.09 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Testing and inspecting underground utilities.
   3. Removing concrete formwork.
   4. Removing trash and debris.
   5. Removing temporary shoring and bracing, and sheeting.
   6. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 98 percent.
   3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material at 98 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:
   1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   2. Shape subbase course to required crown elevations and cross-slope grades.
   3. Place subbase course 6 inches or less in compacted thickness in a single layer.
   4. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   5. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
   2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
   1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 22 00 - SITE GRADING

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the requirements for rough and finish grading of sites requiring adjustment of soil elevations.

1.02 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.03 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ASTM - American Society for Testing of Materials
   2. OSHA - Occupational Safety and Health Administration

1.04 RELATED SECTIONS

A. Section 31 25 13 – Storm Water Pollution Prevention

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Topsoil: Topsoil shall be a sandy loam material of good quality that will readily support vegetation of the type normally growing in the area. Topsoil may be obtained from excavation related to the project site to the extent possible. Contractor shall import topsoil at no additional cost to Owner if sufficient topsoil is not salvaged from the project site.

PART 3 - EXECUTION

3.01 PREPARATION

A. Location of Existing Utilities: The omission from or the inclusion of utility locations shown on the Drawings is not to be considered as the nonexistence of or

the definite location of existing underground utilities. The exact location of existing underground utilities is not known. Contractor shall verify the existence and location of all existing underground utilities in the area of the work.

B. Protection of Existing Utilities: Contractor shall take the necessary precautions to protect all existing utilities from damage due to his operations. Any damage to the existing utilities will be repaired at the Contractor's expense by qualified personnel.

C. Convenience to Public: All work shall be performed in a manner that will cause as little inconvenience to the public as possible. All excavated material shall be kept trimmed such that minimum inconvenience is caused to the public or adjoining property owners. At locations deemed necessary by the Engineer, excavations shall be bridged in a secure manner so as to prevent serious interruption of travel and to provide access to fire hydrants, public property, and private property. All bridging shall meet OSHA requirements.

D. Damage to Existing Property: The Contractor will be held responsible for any damage to existing structures, work, materials, or equipment because of his operations and shall repair or replace any damage at no additional cost to the Owner. The Contractor shall protect all existing structures and all other existing property from damage, and shall provide all bracing, shoring, or other work necessary for such protection.

E. Land for Construction Purposes: The Contractor will be permitted to use available space belonging to the Owner for construction purposes and for the storage of materials and equipment. The location and extent of the areas so used shall be as designated and approved by the Owner. It shall be clearly understood that the responsibility for the protection and safekeeping of equipment and materials on or near the site will be wholly and entirely that of the Contractor and that no claim whatsoever shall be made against the Owner by reason of acts occurring upon said substances by employees or trespassers. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials and equipment, as determined by the Engineer, the Contractor owning or responsible for the stored materials or equipment shall immediately move same. No materials or equipment may be placed upon the property of the Owner until the Owner has approved the proposed location contemplated by the Contractor to be used for storage.

F. Verification of Grades of Existing Adjacent Facilities: When the elevation of the site grading to be performed is dependent on the elevation of existing structures such as building slabs, sidewalks, culverts, etc., the Contractor, prior to beginning any work in the area of the existing structure which is dependent on the elevation of the existing structure, shall verify that the elevation of the existing structure is as shown on the Drawings. If the elevation of the existing structure differs from that shown on the Drawings, the Contractor shall notify the Engineer immediately

prior to proceeding. Proposed sidewalks parallel to and adjacent to a building and at a building entrance must be handicapped accessible.

G. Work Within Public and Railroad Right-of-Way: When any part of the project falls within County, State, or Railroad right-of-way, all work within such right-of-way shall be conducted in accordance with the requirements of each agency or Railroad.

H. Maintenance of Traffic: The Contractor shall conduct his work such that traffic whether vehicular or pedestrian, will be maintained at all times. If required to maintain traffic, the Contractor shall construct at his expense, temporary detours or other temporary structures.

I. Bench Marks, Monuments and Stakes: Contractor shall not disturb any bench marks or property line monument in the performance of the work. In the event it becomes necessary to remove any bench mark or property line monument in the performance of the work, the Contractor shall notify the Engineer prior to removal so that such points may be referenced, in preparation of replacement. All grade stakes shall be carefully maintained during the progress of the work to protect proper grade lines of the finished work. Bench marks, property line monuments, and stakes destroyed by Contractor will be replaced by a registered professional land surveyor at Contractor's expense.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. General: Perform grading and compaction of site to the lines, grades, and densities shown on the Drawings and as described in the specifications.

B. Clearing: All trees and vegetation, except such trees and vegetation that are to remain in place as shown on Drawings and as designated by the Engineer, shall be removed from the site. Trees and other vegetation to be left standing shall be thoroughly protected from damage by the erection of barriers or by such other means as the circumstances require. Clearing operations shall be conducted so as to prevent damage by falling trees to trees left standing, to existing structures and installations and to those under construction, and so as to provide for safety of employees and others.

C. Grubbing: All roots and stumps shall be grubbed and completely removed from the soil in the project area. Where grubbing operations are performed, the soil shall be recompacted to a density equal to that of the surrounding undisturbed soil. All debris resulting from grubbing operations shall be removed from the site by the Contractor and legally disposed of.

D. Excess Excavated Material: Unless otherwise shown on the Drawings or in other sections of these Specifications, all materials not suitable for use and excavated

material in excess of that needed for embankment shall be removed from the site and disposed by the Contractor.

E. Adjustment of Manhole Top Elevations: Existing manholes, sanitary sewer cleanouts and valve boxes shall be protected from damage during construction operations by the Contractor. In the event that they are damaged, they shall be repaired by the Contractor and the entire cost borne by him. Their tops shall be adjusted by Contractor in elevation where necessary to match the proposed grading plan.

F. Disposal of Base Material: Base material removed due to project operations shall be transported to an on-site stockpile area designated by the Owner. Unsuitable material will be disposed of by the Contractor at no additional cost to Owner.

G. Embankment: Non-paved areas which require fill material shall be filled with soil free of rock and organic matter. The embankment shall be placed in eight (8) inch maximum lifts and compacted to a minimum 90% of Standard Proctor as measured by ASTM D-698. The final lift shall consist of not less than four (4) inches of topsoil at finished grade. Areas under proposed pavement or structures which require fill material shall be filled with soil free of rocks and organic matter. The embankment shall be placed in eight (8) inch maximum lifts compacted to a minimum of 95% of standard proctor as measured by ASTM D-698.

H. Grading: The entire site shall be graded to the grades shown on the Drawings, including pavements. Areas not under pavement or structures which have been excavated or which have received fill material shall have a minimum of four (4) inches of topsoil at finished grade. If four (4) inches of topsoil does not remain after excavation in excavated areas, the Contractor shall overexcavate as required to place the required thickness of topsoil. Topsoil shall be compacted sufficiently to prevent future settling.

I. Erosion Control: The Contractor shall employ measures and construction practices to control soil erosion at or adjacent to the project site. Adequacy of erosion control is the responsibility of Contractor and may include, but shall not be limited to filter fabric fences, rock dams, hay bale dams and berms. See Part 1 of this section of the specifications for additional requirements regarding prevention of stormwater pollution.

J. Final Cleanup: Upon completion of the work and before acceptance and final payment, the Contractor shall remove rubbish, unused materials and temporary structures from the limits of the project and restore that which has been damaged during the prosecution of the work. The Contractor shall remove temporary erosion control devices and materials after establishment of permanent vegetation.

3.03 REPAIR/RESTORATION

A. The Contractor shall repair and correct any areas of erosion during the progress of construction and until final acceptance of the project.

3.04 FIELD QUALITY CONTROL

A. Contractor shall provide Owner's laboratory access to each lift of fill for density testing. Notify Engineer at least 24 hours before completion of each lift to allow scheduling of testing.

END OF SECTION 31 22 00

SECTION 31 23 16.16 - EXCAVATING, BACKFILLING, AND COMPACTING FOR STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the excavation for all structures except pipe utility systems, the backfilling around completed structures and the disposal of all excess excavated material. All operations required for the proper completion of the excavation work, including sheeting, shoring, bracing, dewatering of excavations, and compaction of backfill are included under this section.

1.02 RELATED SECTIONS

A. Section 31 25 13 - Storm Water Pollution Prevention

B. Section 31 50 00 - Excavation Safety

C. Section 31 23 23.46 - Cement Stabilized Sand

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ASTM - American Society of Testing and Materials
   2. AASHTO - American Association of State Highway and Transportation Officials
   3. OSHA - Occupational Safety and Health Administration

1.05 SUBMITTALS

A. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed.

B. Submit suitable sample quantities of excavated and/or backfill materials.

1.06 PROJECT / SITE CONDITIONS

A. Contractor shall be responsible for locating all underground utilities. All, if any, existing underground utilities which are shown on the Drawings are for the sole purpose of making the Contractor aware that they exist. The Owner or the Engineer does not guarantee the accuracy of the existing underground utilities which are shown on the Drawings. All costs incurred for locating existing underground utilities shall be the responsibility of the Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Regular Backfill. Material for regular backfill shall be obtained from the excavation and shall be subject to the approval of the Engineer. Where excavated material is deemed unsuitable, as determined by the Engineer, the Contractor is responsible for obtaining, hauling, and properly placing suitable borrow material. Suitable material shall be free of vegetation, clods, lumps, roots, debris, and other foreign material.

B. Sand Backfill. Sand backfill shall be used where shown on the Drawings or as specified herein. Material used as sand backfill shall be subject to the approval of the Engineer. Sand backfill provided shall be a clean bank sand from an approved source. The sand shall be free of organic matter, stones, lumps of clay and any other foreign materials. The sand shall be such that not more than twelve percent (12%) by weight shall pass the 200 mesh sieve and have a plasticity index (P.I.) that does not exceed 4.0.

C. Granular Fill. Granular fill shall be used where shown on the Drawings or as specified herein. Material used as granular fill shall be subject to the approval of the Engineer. Granular fill shall consist of free flowing materials such as sand, gravel, or a mixture of sand and gravel and shall be free of organic matter, stones, lumps of clay and any other foreign materials. Provide sand, crushed stone screenings, crushed gravel screenings, or concrete to fill the voids in the top surface of the granular fill.

D. Cement Stabilized Sand Backfill. Cement stabilized sand shall be used where shown on the Drawings or as specified herein and shall conform to applicable section.

PART 3 - EXECUTION

3.01 PREPARATION

A. Bench Marks, Stakes, and Monuments. No work shall be performed that will destroy or disturb any bench marks or property line monuments. In the event that it becomes necessary to remove any bench mark or property line monument in the performance of the work, the Contractor shall notify the Engineer prior to removal so that such points may be referenced in preparation for replacement. All costs to reestablish disturbed or destroyed bench marks and property line monuments shall be the responsibility of the Contractor.

B. Clearing and Grubbing. All trees and vegetation, except such trees and vegetation that are to remain in place as designated by the Drawings shall be removed from the site. Trees and other vegetation to be left standing shall be protected from damage by the erection of barriers or by such other means as the circumstances require as approved by the Engineer. Clearing operations shall be conducted so as to prevent damage by falling trees to trees that are to be left standing, to existing structures and equipment, and to structures which are under construction. Perform clearing operations so as to provide safety for employees and other bystanders. All roots, stumps and other debris shall be removed from the site. All depressions resulting from these removals shall be filled with suitable materials and compacted to make the surface conform to the surrounding grounds.

C. Protection of Existing Features. Adequately protect all existing structures, utilities, trees, vegetation and other permanent objects. Costs resulting from damage to any of these items will be charged to the Contractor. Any repairs to these items shall be accomplished by qualified personnel and shall be conducted in a timely fashion. The Contractor will also be charged and be responsible for damage to facilities scheduled for later removal or demolition if the damage impairs operation to the extent that temporary replacement or repair is required.

D. Erosion Control. Employ measures and construction practices to prevent significant erosion at, or adjacent to, the project site including migration of silt or soil from the project site. Adequacy of erosion control is subject to the approval of the Engineer and includes, but shall not be limited to, filter fabric fences, dams and berms. Erosion control shall begin at the onset of the project and be maintained throughout the duration of the work until final acceptance.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. General. Perform all excavations to the lines and grades shown on the Drawings. Complete all backfilling to the surface of the natural ground or to the lines and

grades shown on the Drawings. All work performed under this specification shall be completed in strict accordance to the rules and regulations of the Federal Occupational Safety and Health Act.

B. Excavation. Excavations shall be made of sufficient width to permit the application of wall waterproofing when required, removal of forms, installation of services, and for inspection except where concrete for footings is authorized by the Engineer to be deposited directly against the excavated surfaces. Undercutting is not permitted. Sides and bottom of excavations shall be cut sharp and true. When machinery is used for making excavations, the lower three (3) inches shall be excavated by hand except where a suitable cutting screed is provided as an attachment to the excavating machine. Where excavations under footings are made to a greater depth than indicated on the drawings, fill will not be permitted and concrete shall be placed to the bottom of the excavation. When applicable, proper allowance shall be made for granular fill under slabs. Any top soil over excavated areas shall be separately stockpiled at a convenient place and later used as top dressings for all new berms and embankments to a minimum depth of four (4) inches.

C. Shoring, Bracing and Dewatering. Provide shoring, bracing and dewatering of excavations required to properly and safely complete the work. Construct shoring and bracing to prevent the excavation from extending beyond specified or indicated limits and to protect workmen. Keep excavations dewatered by drainage, pumps or well points as necessary while work is in progress. Remove shoring, bracing and sheathing as excavations are backfilled in a manner to prevent caving.

D. Backfill at Structures. Prior to backfilling, and after completion of foundation footings, walls and any other construction below the elevation of the final grades, all forms shall be removed and the excavation shall be cleaned of all trash and debris. Place specified and/or approved backfill material in horizontal layers not exceeding the thicknesses as outlined herein. Trucks or heavy equipment for depositing backfill shall not be used within five (5) feet of building walls, piers, or other facilities which may be damaged by their weight or operation. Wall waterproofing materials shall not be damaged when placing backfill. Backfilling shall begin only when acceptable to the Engineer and in no case will backfill be placed against masonry walls of basements or walls four (4) feet and over in height that are unsupported on the inside face until these walls have been in place for seven (7) good curing weather days.

E. Granular Fill Under Slabs. Place granular fill under all slabs. Thickness of granular fill under slabs shall be a six-inches (6") or as shown on the Drawings. Voids in the top surface of the granular fill shall be filled with the prescribed material and leveled to provide a smooth, even surface. No granular fill shall be placed without the knowledge of the Engineer.

F. Compaction. Compaction and placement of materials shall be at the locations shown on the Drawings. Place and compact materials at the optimum moisture as follows:

1. Regular Backfill. Place in eight-inch (8") maximum layers, loose measure. Compact to not less than 92% Standard Proctor density as determined by ASTM D-698.
2. Sand Backfill. Place six-inch (6") maximum layers, loose measure. Compact to not less than 95% Standard Proctor density as determined by ASTM D-698.
3. Granular Fill. Place six-inch (6") maximum layers, loose measure. Compaction of granular fill shall be accomplished by such methods that meet with the approval of the Engineer.
4. Cement Stabilized Sand Backfill. Place cement stabilized sand backfill in accordance with the provisions of applicable section.

G. Grading. Upon the completion of structures or slabs, grade the surrounding earth to the finished line and grade as shown on the Drawings. Evenly spread the stockpiled top soil over all embankments, berms, slopes and surrounding grounds. The top soil shall be harrowed and dragged so as to break up all lumps in preparation of sodding or seeding Unless specifically shown on the Drawings, drainage shall away from all structures and slabs.

3.03 REPAIR / RESTORATION

A. The Contractor shall correct any erosion of embankments or other areas during the progress of construction and up to the final acceptance of the entire project.

3.04 FIELD QUALITY CONTROL

A. Placement of any backfill or fill materials shall not be done without the knowledge of the Engineer. Contractor is responsible for notifying the Engineer prior to starting backfill operations. Notification will be such that will allow the Engineer sufficient time to observe the excavated areas prior to the beginning of backfill operations.

3.05 ADJUSTING / CLEANING

A. Dispose of excess or unsuitable excavated materials at a location away from the project site limits and in a legal manner. If acceptable to the Engineer, disposal of such materials may be within the site limits.

END OF SECTION 31 23 16

SECTION 31 23 16.19 - EXCAVATING, BACKFILLING, AND COMPACTING FOR PAVEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the requirements for the excavation, backfilling, embankment, and compacting for all types of pavement including, but not limited to, concrete pavement and hot mix asphalt concrete pavement. Also included in this specification are the requirements for clearing and grubbing for roadway construction and the requirements for traffic control in the construction of a roadway.

1.02 RELATED SECTIONS

A. Section 31 25 13 – Storm Water Pollution Prevention

B. Section 31 32 13.19 – Lime Stabilization of Materials in Place

C. Section 31 50 00 – Excavation Safety

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ASTM - American Society of Testing and Materials
   2. AASHTO - American Association of State Highway and Transportation Officials
   3. OSHA - Occupational Safety and Health Administration

1.05 DEFINITIONS

A. Embankment. Embankment is hereby defined as any additional placement and compaction of material required to construct a designated roadway section, a roadway embankment, levee and/or dike.

B. Backfill. Backfill is hereby defined as any additional placement and compaction of material required to install all structures associated with the construction of a

designated roadway section such as curb and gutters, storm sewer inlets, guardrail or other similar roadway structures.

C. Excavation. Excavation is hereby defined as the removal and subsequent handling of all materials excavated or otherwise removed in the performance of the work, regardless of type, character, composition or condition thereof. All excavation shall be unclassified and includes the removal of all material regardless of the nature of the material unless otherwise indicated in the bid form.

D. Borrow. Borrow is hereby defined as the material which is stripped, excavated, transported and properly utilized as backfill or embankment material and is obtained only from an approved and/or designated source.

1.06 SUBMITTALS

A. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed. Submit suitable sample quantities of embankment, backfill, and/or subgrade materials when requested by the Engineer.

1.07 COMPLIANCE WITH REGULATORY AGENCIES

A. The Contractor shall comply with the requirements of all pertinent regulatory agencies as applicable to the project. The Contractor shall meet the requirements of the EPA Clean Water Act as it applies to pollution from stormwater runoff. When the construction site is five or more acres, the Contractor will be the Operator of the site as defined by the EPA, and Contractor shall prepare and implement a Stormwater Pollution Prevention Plan, according to EPA requirements including the notifications required by the EPA.

1.08 DELIVERY, STORAGE, AND HANDLING

A. All material used for embankment or backfill shall be delivered, stored, and handled in a manner that will prevent any harmful contamination of the material or damage to any adjacent property or structures. The delivery, storage, and handling of embankment and backfill materials is subject to the review of the Engineer.

1.09 PROJECT / SITE CONDITIONS

A. Contractor shall be responsible for locating all underground utilities which are in conflict with the proposed work.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Embankment. Furnish embankment material which is obtained from roadway, borrow, channel and structural excavations. Embankment material shall be obtained only from an approved source and shall meet the approval of the Engineer. In general, embankment material shall consist of earth which is free from rocks, clods, vegetation or other foreign material. Each layer of embankment shall be uniform as to material, density and moisture content and shall be suitable for forming a stable embankment. Other requirements for embankment material shall be as shown on the Drawings.

B. Backfill. Furnish backfill material in accordance with the requirements as shown on the Drawings. Backfill material shall be obtained only from an approved source and shall meet the approval of the Engineer. Obtain approved backfill material from roadway, borrow, channel and structural excavations.

C. Subgrade Material. Use existing subgrade material, or when necessary furnish subgrade material, which contains sufficient fines to form a firm subgrade capable of being shaped and compacted to the lines, grades and densities shown on the Drawings.

1. Lime Stabilization. If required, lime stabilization of subgrade shall be in accordance with applicable section.
2. Cement Stabilization. If required, cement stabilization of subgrade shall be in accordance with applicable section.

D. Topsoil. Furnish topsoil material which is capable of sustaining vegetation. All topsoil material and the source from which it comes shall meet with the approval of the Engineer and shall be obtained from roadway, borrow, channel and structural excavations. When acceptable to the Engineer, the top four (4) inches of roadway, channel and structural excavations shall be stripped and separately stockpiled for later use as topsoil. When the top four (4) inches of roadway, channel or structural excavations do not, in the Engineer's opinion, provide the necessary material for sustaining vegetation, or there does not exist enough of this material, topsoil shall be obtained from an acceptable borrow source. All existing large vegetation or other unsuitable material shall be removed from topsoil before it is stockpiled or transported.

PART 3 - EXECUTION

3.01 PREPARATION

A. Rights-of-Way. The necessary rights of way for the work will be provided by the Owner. The Contractor shall confine his construction operations to the immediate vicinity of the location shown on the Drawings, and shall use due care in placing construction tools, equipment, excavated materials, and paving materials and supplies, so as to cause the least possible damage and interference with traffic. The placing of such tools, equipment, and materials shall be subject to the approval of the Engineer.

B. Work Within Highway Right-of-Way. All work performed, and all operations of the Contractor, his employees, or his subcontractors, within the limits of highway right-of-way shall be in conformity with the requirements of the highway authority owning, or having jurisdiction over, the right-of-way in each case.

C. Bench Marks, Stakes, and Monuments. No work shall be performed that will destroy or disturb any bench marks or property line monuments. In the event that it becomes necessary to remove any bench mark or property line monument in the performance of the work, the Contractor shall notify the Engineer prior to removal so that such points may be referenced in preparation for replacement. All costs to reestablish disturbed or destroyed bench marks and property line monuments shall be the responsibility of the Contractor.

D. Clearing and Grubbing. All trees and vegetation, except such trees and vegetation that are to remain in place as designated by the Engineer, shall be removed from the site. Trees and other vegetation to be left standing shall be protected from damage by the erection of barriers or by such other means as the circumstances require. Clearing operations shall be conducted so as to prevent damage by falling trees to trees that are to be left standing, to existing structures and equipment, and to structures which are under construction. Perform clearing operations so as to provide safety for employees and other bystanders. All roots, stumps and other debris shall be removed to a depth of two (2) feet below the lowest elevation of an excavation or below the existing surface in area to receive embankment. All depressions resulting from these removals shall be filled with suitable materials and compacted to make the surface conform to the surrounding grounds.

E. Protection and Maintenance of Public and Private Property. The Contractor shall protect, shore, brace, support, and maintain all underground pipes, conduits, drains, and other underground facilities uncovered or otherwise affected by the construction work performed by him. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, and other surface structures affected by the construction operations in connection with the performance of the contract,

together with all sod and shrubs in yards and parking areas removed or otherwise damaged, shall be restored to the original condition thereof as determined by the Engineer. All replacements of such underground construction and surface structures, or parts thereof, shall be made with new materials conforming to the requirements of these specifications or, if not specified, as acceptable to the Engineer. Utility poles and fire hydrants will be relocated by others. The Contractor shall be responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property facilities, regardless of location or character, which may be caused by moving, hauling, or otherwise transporting equipment, materials or men to or from the work or any part or site thereof, whether by him or his subcontractor(s). The Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction over, the damaged property or facility concerning its repair or replacement or payment of costs incurred with said damage. All fire hydrants and water control valves shall be kept free from obstructions and available for use at all times.

F. Erosion Control. Employ measures and construction practices to prevent erosion at, or adjacent to, the project site. Adequacy of erosion control is subject to the review of the Engineer and includes, but shall not be limited to, filter fabric fences, rock dams and berms. Erosion control shall begin at the onset of the project and be maintained throughout the duration of the work until final acceptance.

G. Traffic Control. Provide and maintain traffic control in conformity with the applicable statutory requirements and, within highway right-of-way, as required by the authority having jurisdiction thereover. Adequate traffic control devices shall be in place prior to removal of any existing control devices, construction equipment move-in or any work within public right-of-way. Traffic control shall be in accordance with the Texas Manual on Uniform Traffic Control Devices. The Contractor shall notify all required emergency service providers in the event of a road closure or other activity that may impair the emergency travel of the provider.

1. Maintenance of Traffic. Conduct work in a manner that will interfere as little as possible with public travel, whether vehicular or pedestrian, whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private. The Contractor shall, at his own expense, provide and maintain suitable and safe bridges, detours, or other temporary structures for the accommodation of public and private travel and shall give reasonable notice to owners of private drives before interfering with them; provided however, that such maintenance of traffic will not be required at any point where the Contractor has obtained permission from the owner and tenant of the private property involved, to obstruct traffic at any designated point thereon and for the duration of whatever period of time as may be agreed on.

2. Barricades, Lights, and Signs. All streets, roads, highways and other public thoroughfares which are closed to traffic shall be protected by means of effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersection, public highway or street on each side of the blocked section. All open trenches or other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning lights and signs. All barricades and obstructions shall be illuminated by means of warning lights. Materials stored upon or alongside public streets and highways shall be so placed, and the work conducted at all times, as to cause minimum obstruction and inconvenience to the traveling public.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. General. Perform all excavations, construction of embankments, backfilling, compacting and subgrade preparation to the lines, grades, and densities shown on the Drawings. All work performed under this specification shall be completed in strict accordance to the rules and regulations of the Federal Occupational Safety and Health Act.

B. Excavation. All excavations for pavement and associated structures shall be held to the minimum required for the proper performance of the work. Blasting is hereby strictly prohibited to aid in the performance of the excavation work. The Contractor is expected to familiarize himself completely with the type of excavation to be performed and the type of materials to be handled. There will be no consideration of claims for extra compensation due to encountering difficult or unstable material in the excavations to be made.

C. Subgrade Preparation. Uniformly place and spread approved subgrade material which has been obtained from a borrow source and compact to the required thickness using approved compacting equipment. Subgrade material which is existing or is hauled in from another source, and is not to be cement or lime stabilized, shall be within 2% of optimum moisture content and shall be compacted to a minimum 95% Standard Proctor as determined by ASTM D698. Compaction of subgrade which is to be cement stabilized shall be in accordance with applicable section. Compaction of subgrade which is to be lime stabilized shall be in accordance with applicable section.

D. Embankments. No embankment work shall be performed without the Engineer's approval of the embankment material. Unless otherwise shown on the Drawings, embankments shall be constructed in successive layers for the full width of the cross section and in appropriate lengths which are suitable for the sprinkling and compaction methods being used. Maximum depth of layers before compaction

shall be six (6) inches. Form each successive layer of embankment by utilizing equipment which will evenly spread and distribute the piles or windrows of material which have been placed from excavations or hauling equipment. All embankment material shall be placed by blading or some other approved similar method. All clods and lumps shall either be removed or broken and then subsequently blended into the embankment material by blading, harrowing or other acceptable method such that each layer is of uniform density. When necessary, the Contractor shall evenly sprinkle each layer of embankment material to obtain the required moisture content that will allow for maximum compaction. Contractor shall be responsible for obtaining a uniform moisture content within 2% of optimum moisture throughout each successive layer of embankment material by using such methods as may be necessary. Each layer of embankment shall be compacted to a minimum 92% Standard Proctor as determined by ASTM D698.

E. Backfilling and Compacting. No backfilling and compacting around any pavement or associated structures shall be done without the prior knowledge of the Engineer. Place and compact approved backfill at all required locations including behind curbs and around inlets when necessary. Unless otherwise shown on the Drawings, backfill shall be placed and compacted in maximum eight (8) inch layers to the density of the surrounding earth or the density shown on the Drawings.

F. Grading. Upon the completion of the pavement, grade the surrounding earth and ditches to the finished line and grade as shown on the Drawings. Evenly spread the stockpiled topsoil over all embankments, berms, slopes and surrounding grounds. The topsoil shall be harrowed and dragged so as to break up all lumps in preparation of sodding or seeding. Unless specifically shown on the Drawings, drainage shall be away from all structures and slabs.

3.03 REPAIR / RESTORATION

A. The Contractor shall correct any erosion of embankments or other areas during the progress of construction and up to the final acceptance of the entire project.

3.04 FIELD QUALITY CONTROL

A. Placement of any backfill or embankment materials shall not be done without the prior knowledge of the Engineer. Contractor is responsible for notifying the Engineer prior to starting backfill operations. Notification will be such that it will allow the Engineer sufficient time to observe the excavated areas prior to the beginning of backfill operations.

3.05 ADJUSTING / CLEANING

A. Dispose of excess or unsuitable excavated materials at a location away from the project site limits and in a legal manner. Upon approval of the Engineer, disposal of such materials may be within the site limits.

END OF SECTION 31 23 16.19

SECTION 31 23 23.46 - CEMENT STABILIZED SAND

PART 1 - GENERAL

1.01 SUMMARY

A. This section provides for the use of cement stabilized sand as a utility bedding or backfill material or for structural backfill.

1.02 RELATED SECTIONS

A. Section 31 23 33 - Excavation, Trenching and Backfilling for Utilities

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ASTM - American Society of Testing Materials

1.05 SYSTEM DESCRIPTION

A. Provide sand-cement mixture that will produce a minimum unconfined compressive strength of 100 pounds per square inch (psi) in 48 hours.

1.06 QUALITY ASSURANCE

A. Upon request of the Engineer, the Contractor or his supplier will furnish samples of the sand and cement for testing before and/or during project construction. Samples shall be submitted two (2) days prior to stabilized sand being delivered to the project site. If the material source is changed during project construction, new samples shall be submitted.

1.07 DELIVERY, STORAGE AND HANDLING

A. Material not in place within three (3) hours of mixing will be rejected.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Sand. Use clean durable sand containing not more than the following:

1. Deleterious Materials.
   a. Clay lumps, ASTM C-142; less than 0.5 percent (0.5%).
   b. Lightweight pieces, ASTM C-123; less than five percent (5.0%).
   c. Organic impurities, ASTM C-40; shall not show a color darker than the standard color.
   d. Other deleterious materials such as coal, shale, coated grains of soft flaky particles; less than two percent (2.0%).
2. Plasticity index shall be four (4) or less when tested in accordance with ASTM D-43 and ASTM D-424.
3. Gradation Requirements.

	% Retained
3/8-inch sieve	0%
1/4-inch sieve	0% - 5%
10-mesh sieve	5% - 35%
20-mesh sieve	15% - 55%
40-mesh sieve	35% - 85%
60-mesh sieve	60% - 95%
100-mesh sieve	80% - 97.5%
200-mesh sieve	95% - 100%
270-mesh sieve	100%

4. Color test ASTM C40. Color not darker than standard color.

B. Portland Cement. Furnish Portland cement to conform with ASTM C-150, Type 1.

C. Water. Water shall be reasonably clean and free from injurious amounts of oil, acid, alkalies, salt, organic matter, or other deleterious material.

PART 3 - EXECUTION

3.01 PREPARATION

A. Add not less than 1 1/2 sacks of Portland cement to stabilize one (1) cubic yard of sand mixture. Mix thoroughly in an approved pug-mill type mixer. Stamp batch ticket with the time of loading.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Bedding:
   1. Place cement-sand in a trench or excavation prepared for utility pipe to the depth shown on the drawings.
   2. After bedding material is in place, set pipes in position to grade.
   3. Add additional cement-sand material around pipe, filling to at least twelve inches (12") above pipe crown. Place cement-sand material at optimum moisture content, and in layers not to exceed six-inches (6") measured loose.
   4. Compact with mechanical hand tamps to at least 95 percent (95%) of Standard Proctor Density, ASTM D-698.

B. Foundations: Use cement stabilized sand for stabilizing below the foundation for precast manholes, inlets or concrete structures.

C. Backfill:
   1. When required, place cement-sand in utility trenches as backfill for lines under existing or future pavement.
   2. Place cement-sand material at optimum moisture content in layers not to exceed twelve inches (12"), measured loose.
   3. Compact with mechanical hand tamps to at least 95 percent (95%) of Standard Proctor Density, ASTM D-698.

3.03 FIELD QUALITY CONTROL

A. Allow access to completed portions of bedding or backfill for field density testing by nuclear method.

END OF SECTION 31 23 23.46

SECTION 31 23 33 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the requirements for the excavation, trenching and backfilling of the following utilities and their respective appurtenances:
   1. Storm sewers,
   2. Sanitary sewers,
   3. Water lines,
   4. Gas lines,
   5. Electrical cables and ducts.

1.02 RELATED SECTIONS

A. Section 31 25 13 - Storm Water Pollution Prevention

B. Section 31 50 00 - Excavation Safety

C. Section 31 23 23.46 - Cement Stabilized Sand

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1.ASTM - American Society for Testing of Materials
   2.OSHA - Occupational Safety and Health Administration
   3.AASHTO - American Association of State Highway and Transportation Officials

1.05 SUBMITTALS

A. When requested, submit adequate amounts of backfill material for evaluation by the Engineer. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed.

1.06 SCHEDULING

A. No open excavation or trenches shall be left overnight without proper lighting, barricades, and pedestrian fencing.

B. Schedule backfilling such that there is a minimum of excavations and trenches that are left open during hours of no work.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Cement Stabilized Sand. When required, provide cement-stabilized sand backfill material in accordance with applicable section.

B. Bank Sand. When required, provide clean bank sand from an approved source which is free of clay, organic material or other foreign substances. The bank sand shall be such that not more than 12 percent by weight passes the 200 mesh sieve and the plasticity index (P.I.) shall not exceed 4.0.

C. Select Material. Select material shall be excavated trench material or imported material which is free from rock fragments and clods that will not break down when compacted unless the rocks or clods are 1-1/2 inches or smaller and scattered in the spoil. Select material shall be free of organic materials and free of sharp or angular materials which could damage the utility being installed or any coating/cover on the utility being installed.

D. Common Backfill. Common backfill shall be excavated trench material free of organic, soft, or spongy materials.

E. Soil Embedment Materials. Soils to be used for embedment material shall be classified according to the Unified Soils Classification System (USCS) in ASTM D2487, Standard Method for Classification of Soils for Engineering Purposes. Install embedment material in accordance with ASTM D-2321. The following USCS Soils Classifications correspond to the soil classifications required for the various types of embedments shown on the plan details and/or listed in other sections of these specifications:

1. Class I Soils. Manufactured angular, granular material, 1/4 to 1-1/2 inches size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells. Class I soils are not defined in ASTM D2487 and are subject to approval before being used.

2. Class II Soils. In accordance with ASTM D2487, less than 5% pass No. 200 sieve.
    a. GW Soil Type: Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
    b. GP Soil Type: Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
    c. SW Soil Type: Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
    d. SP Soil Type: Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
3. Class III Soils. In accordance with ASTM D2487, more than 12% pass No. 200 sieve. Soils with 5% to 12% pass No. 200 sieve fall in borderline classification, for example, GP-GC.
    a. GM Soil Type: Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
    b. GC Soil Type: Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
    c. SM Soil Type: Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
    d. SC Soil Type: Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
4. Class IV Soils.
    a. ML Soil Type: Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
    b. CL Soil Type: Inorganic clays of low to medium plasticity, gravel clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
    c. MH Soil Type: Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
    d. CH Soil Type: Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
5. Class V Soils.
    a. OL Soil Type: Organic silts and organic silty clays of low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
    b. OH Soil Type: Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.

c. PT Soil Type: Peat, muck and other highly organic soils.

F. Concrete Embedment. Concrete used for utility embedment shall have minimum strength of 3,000 psi at twenty-eight (28) days. Dry mix will not be permitted. The concrete cushion portion of the embedment or encasement shall be mixed moist or damp such that a slump of not more than 1-inch is achieved. Concrete for the sides and top, if required, shall be mixed such that a slump of not less than 1-inch, and not more than 3-inches, is obtained.

PART 3 EXECUTION

3.01 PREPARATION

A. Location of Existing Utilities. Contractor shall verify the existence and location of all existing underground utilities along the route of the work.

B. Protection of Existing Utilities. Contractor shall take the necessary precautions to protect all existing utilities from damage due to his operations. Any damage to the existing utilities will be repaired at the Contractor's expense by qualified personnel. In order to protect existing utilities that are required to be exposed, Contractor's operation shall be such that a sufficient distance back from the edge of the excavation is maintained to avoid overloading and to prevent slides or caving. No unnecessary excavation or exposing of existing underground utilities will be allowed.

C. Convenience to Public. All trenching and excavating shall be performed in a manner that will cause as little inconvenience to the public as possible. All excavated material shall be kept trimmed such that minimum inconvenience is caused to the public or adjoining property owners. At street crossings, sidewalks and other points deemed necessary by the Engineer, trenches and excavations shall be bridged in a secure manner so as to prevent serious interruption of travel and to provide access to fire hydrants, public property, and private property. All bridging shall be preapproved by the Engineer.

D. Erosion Control: Employ measures and construction practices to prevent erosion at, or adjacent to, the project site. Adequacy of erosion control is subject to the approval of the Engineer and includes, but shall not be limited to, filter fabric fences, rock dams and berms. Erosion control shall begin at the onset of the project and be maintained throughout the duration of the work until final acceptance.

E. Traffic Control: Provide and maintain traffic control in conformity with the applicable statutory requirements and within highway right-of-way as required by the authority having jurisdiction thereover. Adequate traffic control devices shall

be in place prior to removal of any existing control devices, construction equipment move in or any work within public right-of-way. Traffic control shall be in accordance with the Texas Manual on Uniform Traffic Control Devices. The Contractor shall notify all required emergency service providers in the event of a road closure or other activity that may impair the emergency travel of the provider.

1. Maintenance of Traffic. Conduct work in a manner that will interfere as little as possible with public travel, whether vehicular or pedestrian, whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private. The Contractor shall, at his own expense, provide and maintain suitable and safe bridges, detours, or other temporary structures for the accommodation of public and private travel and shall give reasonable notice to owners of private drives before interfering with them; provided however, that such maintenance of traffic will not be required at any point where the Contractor has obtained permission from the owner and tenant of the private
property involved, to obstruct traffic at any designated point thereon and for the duration of whatever period of time as may be agreed on.
2. Barricades, Lights, and Signs. All streets, roads, highways, and other public thoroughfares which are closed to traffic shall be protected by means of effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersection, public highway or street on each side of the blocked section. All open trenches or other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning lights and signs. All barricades and obstructions shall be illuminated by means of warning lights. Materials stored upon or alongside public streets and highways shall be so placed, and the work conducted at all times, as to cause minimum obstruction and inconvenience to the traveling public.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. EXCAVATION.

1. General: Excavation shall include the removal of any trees, stumps, brush, debris or other obstacles that may obstruct the line of work, and the excavation and removal of all earth, rock or other material to the extent necessary to install the utility and all appurtenances in conformance with the line and grades shown on the Drawings or as specified herein.
2. Trench Width: The sides of all trenches shall be cut as near vertical as possible. Whenever the prescribed maximum trench width is exceeded for pipe utilities, except as such excess may be required for compliance with Drawings or specifications, the pipe shall be cradled with 2,000 psi concrete at the expense of the Contractor. Unless shown or specified

otherwise, the maximum and minimum trench widths for the associated utility shall be measured at 12-inches above the top of the utility line and shall be as follows:

a. Storm sewers.
   Minimum width: 16-inches plus O.D. of Pipe.
   Maximum width: 24-inches plus O.D. of Pipe.
b. Sanitary sewers.
   Minimum width: 16-inches plus O.D. of Pipe.
   Maximum width: 24-inches plus O.D. of Pipe.
c. Water lines.
   Minimum width: 16-inches plus O.D. of Pipe.
   Maximum width: 24-inches plus O.D. of Pipe.
d. Gas lines.
   Minimum width: 6-inches plus O.D. of Pipe.
   Maximum width: 12-inches plus O.D. of Pipe.
e. Electric cables and ducts.
   Minimum width: 6-inches plus O.D. of Cable / Duct.
   Maximum width: 12-inches plus O.D. of Cable / Duct.

3. Trench Depth. Unless shown or specified otherwise, trenches shall be excavated to a depth such that the following minimum depths of cover are maintained on the associated utility (as measured from final grade):
   a. Water mains: 42-inches of cover.
   b. Sewage force mains: 42-inches of cover.
   c. Gas mains: 36-inches of cover. Gas Services 1-1/4" and Smaller: 18 inches of cover.
   d. Electric cables and ducts: 30-inches of cover, except as shown otherwise on the Drawings or in specific specifications relating to buried electrical lines, or as otherwise required by the National Electrical Code and local electrical codes.
4. Trench Bottom. Accurately grade trench bottom such that uniform bearing and support is provided for the utility being installed. Trench bottom shall be such that the utility is supported along it's entire length by undisturbed soil except where bell holes or depressions are required. When bell holes or depressions are required for the proper installation of a utility, the trench bottom shall be completely graded before the bell hole or depression is excavated. Bell holes or depressions shall be no larger than required for the proper installation of the utility. The following procedures shall be used when various types of trench subgrades are encountered:
   a. Earth Subgrade. Where a firm and stable foundation for the utility being installed can be obtained in the natural soil and where special embedment is not shown on the plan details or specified herein, the bottom of the trench shall be carefully trimmed to fit the lower portion of the utility line. Should the excavation be carried below grade, except when otherwise detailed on the Drawings or specified herein, the Contractor shall refill it with Class I embedment material and tamp

it until it is compacted such that the bottom of the trench is firm and unyielding. This procedure shall be accomplished at the expense of the Contractor.

b. Rock Subgrade. Where the bottom of the excavation for the utility line is in rock or other hard material, the rock or other hard material shall be removed to a depth not less than four (4") inches below subgrade and the bottom of the trench brought to true subgrade elevation by filling with Class I embedment or other suitable materials as approved by the Engineer. The fill shall be compacted by means of tamping until a firm and uniformly unyielding foundation is established for the utility line being installed.

c. Soft Subgrade. Where a soft or spongy material is encountered in the excavation at subgrade level, it shall be removed only if requested by the Engineer. Remove the soft material and replace it with Class I embedment or other suitable materials. The fill replacing the soft material shall be compacted by means of tamping and shall be to a depth that will result in a true trench subgrade that provides a firm and uniformly unyielding foundation for the utility being installed.

5. Sheeting, Shoring, and Bracing. Shore all excavations in accordance with OSHA Standards and the applicable section, or sections, of these specifications. When excavations are made adjacent to existing buildings or other structures, or in paved roadways, particular care shall be taken to adequately sheet, shore, and brace the sides of the excavation to prevent undermining of, or the settlement beneath, the structures or pavements. Underpinning of adjacent structures or pavement, and the costs associated with it, shall be the responsibility of the Contractor. All sheeting, shoring, and bracing shall be done in such a manner that will not cause any caving or sliding of banks and will not endanger any human life or damage any existing structures or property. Fill and compact all holes or voids left by the removal of sheeting, shoring or bracing with suitable materials. If for any reason, the Contractor, elects to leave in place the sheeting, shoring or bracing, no payment will be allowed for such material left in place.

6. Dewatering Excavations. Immediately remove all surface water, ground water or seepage water from sewers, drains, ditches, or other sources which may accumulate in the excavation during construction. Removal of water shall be done by pumping, bailing, draining, well pointing, or other acceptable methods. The Contractor shall have available, at all times, sufficient equipment in proper working order for dewatering excavations. Disposal of all water from excavations shall be in a legal and safe manner. All dewatering of excavations including pumping, bailing, draining, ditching, well pointing, underdrain, etc., is incidental work and will not be paid for separately.

7. Open Cut Excavations. Except where otherwise shown on the Drawings, all utility installations shall be accomplished by open cut. In all cases where open cuts are allowed through pavements, the methods of

construction must meet the requirements of the appropriate regulating agency in all respects including deviations from these specifications or Drawings. Open cut excavations crossing paved or unpaved public roadways and driveways shall be done such that inconvenience to users is minimized. Repair all open cut pavements in accordance with the Drawings details or to the original condition, whichever is more stringent. Repair all open cut pavements in a timely fashion. Where a utility line is to be installed across a paved roadway by open cut, the Contractor, with the approval of the Engineer, may elect to install the utility by boring and in such case will be paid for the corresponding pavement repair if provided for in the bid form.

8. Boring, Jacking or Drilling. When shown on the Drawings, the utility line shall be installed by boring, jacking or drilling under roadways, streets or railroads, or the line shall be installed in a casing that has been placed by boring, jacking or drilling in accordance with requirements of all regulating agencies.
9. Excavation of Appurtenances. Excavate as required for appurtenances of the utility being installed. For manholes and other similar structures leave at least two (2) feet clear between the outer surfaces and the embankment or timber that may be used to hold or protect the banks. Any over excavating below appurtenances is not allowed. If over excavating of appurtenances occurs, the excavation will be refilled with cement stabilized sand or concrete. The cost for this refilling shall be the responsibility of the Contractor.
10. Explosives. The use of explosives to aid excavation work is strictly prohibited.

B. Embedment: All embedment for utilities shall be in accordance with the plan details and shall use the materials outlined in this specification. In general, the embedment zone of a utility line is 4-inches below the bottom of the utility to 12-inches above the top of the utility. All materials for the embedment of a utility being installed shall be placed in layers or lifts that do not exceed 6-inches in thickness. Compaction of embedment zone material shall be in strict accordance with the plan details.

C. Backfilling:
1. General. The four (4) types of backfill that may be used include: cement stabilized sand, bank sand, select fill having a PI between 5 and 20 and common backfill. Install the various types of backfill material in accordance with and at the locations detailed on the Drawings. Backfilling shall include the refilling and consolidation of the required fill in trenches and excavations from the top of the embedment zone of the utility being installed to the surrounding ground surface or to the bottom limits of a required pavement repair as detailed on the Drawings.
   a. Bank Sand or select fill. Install approved bank sand or select fill

backfill in accordance with and in the locations shown on the plan details. Place backfill in maximum 8-inch loose lifts above the embedment zone and compact each layer to 95% Standard Proctor.

b. Common Backfill. Unless specified or shown otherwise on the plan details, backfill all trenches with approved common backfill material from the trench excavation. Place common backfill in 12-inch layers above the embedment zone and compact each layer to 92% Standard Proctor.

2. Compaction and Consolidation of Backfill. Compact each layer of backfill with mechanical equipment to the required density. As an option, the Contractor may elect to consolidate the backfill by jetting and flooding until full settlement has been reached. Jetting and flooding will not be allowed in any areas where the utility system is being installed under a paved section. If used, jetting shall be accomplished by pumping water through a pipe that is slowly inserted vertically into the backfill. The end of the pipe shall be lowered to a point near the top of the embedment zone, taking care not to disturb the bedding or cause the utility to float. The trench shall then be flooded in puddles until no more appreciable absorption of water into the backfill occurs.

3. Excess Material: Excavated material unsuitable for backfilling and excess material shall be disposed of in a manner acceptable to the Engineer.

3.03 REPAIR / RESTORATION

A. Restore surfaces at construction sites to a condition equal to condition prior to construction.

3.04 ADJUSTING / CLEANING

A. All premises shall be left in an "as found" condition.

END OF SECTION 31 23 33

SECTION 31 25 13 - STORM WATER POLLUTION PREVENTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the minimum requirements and responsibilities of the Contractor (Operator) for storm water pollution prevention.

1.02 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.03 REFERENCES

A. The applicable regulations of the following agencies shall apply as if written here in their entirety:
   1. TCEQ - Texas Commission on Environmental Quality
   2. EPA - Environmental Protection Agency

1.04 SYSTEM DESCRIPTION

A. The Contractor shall take all necessary measures to prevent storm water pollution and comply with the applicable requirements of the controlling regulatory agencies as required for the project and any other requirements set forth herein.

1.05 DEFINITIONS

A. For the purposes of the Texas Pollutant Discharge Elimination System (TPDES) general permit, the Contractor is hereby defined as the Operator having operational control over construction Drawings and specifications necessary to meet the requirements of the permit and having day to day operational control of those activities at this construction site which are necessary to provide compliance with the permit.

1.06 SUBMITTALS

A. The Contractor shall submit to Engineer a Storm Water Pollution Prevention Plan (SWP3) when a SWP3 is required for the project. The Contractor shall also submit all required supporting documents including, but not limited to, a Notice of Intent (NOI) and a Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under the Texas Pollutant Discharge Elimination System.

B. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer.

1.07 PROJECT/SITE CONDITIONS

A. Contractor shall develop and implement a storm water pollution prevention plan based on the actual conditions encountered on the project and shall implement the plan and any other requirements in accordance with all applicable laws and regulations. Contractor shall be responsible for determining the area (acres) that will be disturbed to prosecute the work required for the project and take the appropriate actions as outlined in this section based on the disturbed area as described in subsequent paragraphs of this specification.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. For a project where a SWP3 is required to be prepared and implemented by the Contractor, all methods, materials and equipment used to prevent storm water pollution shall be the sole responsibility of the Contractor. Typical drawings and notes may be shown on the Drawings and/or in this specification and may include locations or types of typical structural controls such as silt fencing, sedimentation basins, straw bales, rock berms, and other methods for preventing storm water pollution prevention. The typical drawings and notes that may be shown shall be considered as methods that may be selected for use by the Contractor. **Nothing shown on drawings or described in the specifications for this project relieves the Contractor from sole responsibility for preventing storm water pollution in accordance with the applicable laws and regulations and for preventing property damage from flooding resulting from his storm water pollution prevention methods.** Alternate or additional methods, materials and equipment may be developed and used by Contractor to prevent storm water pollution. Any alternate or additional methods, materials and equipment shall be detailed in the SWP3 that is to be prepared by the Contractor and submitted to the Engineer.

PART 3 - EXECUTION

3.01 STORM WATER POLLUTION PREVENTION REQUIREMENTS

A. Contractor has the sole responsibility for preventing storm water pollution and following all applicable city, state and federal regulations in preventing storm water pollution. The Contractor is hereby designated as the “Operator” of the construction site and has sole responsibility for determining the area that will be

disturbed to prosecute the work. The following paragraphs provide a general description of the requirements for obtaining authorization to discharge storm water under a Texas Pollutant Discharge Elimination System (TPDES) permit based on the size of the project:

B. Large Projects. Large projects are those projects that disturb five (5) acres or more. The Contractor (Operator) shall comply with the following:
   1. Obtain a copy of the most recent version of the TCEQ Construction General Permit and comply with all requirements set forth therein.
   2. Develop and implement a Storm Water Pollution Prevention Plan (SWP3).
   3. Complete and submit a Notice of Intent (NOI) to the TCEQ using the appropriate TCEQ form and instructions.
   4. When applicable, provide notification to the operator of any Municipal Separate Storm Sewer System (MS4) when storm water from the project site will be discharging into the MS4.
   5. Submit a Notice of Termination (NOT) to the TCEQ using the appropriate TCEQ form and instructions once the project site has reached final stabilization.
   6. Pay all fees that may be associated with complying with the requirements for a Large Project including application fees and annual fees.

C. Small Projects. Small projects are those projects that disturb one (1) or more acres, but less than five (5) acres. The Contractor (Operator) shall comply with the following:
   1. Obtain a copy of the most recent version of the TCEQ Construction General Permit and comply with all requirements set forth therein.
   2. Develop and implement a Storm Water Pollution Prevention Plan (SWP3).
   3. Complete and post a site notice using the appropriate TCEQ form.
   4. When applicable, provide notification to the operator of any Municipal Separate Storm Sewer System (MS4) when storm water will be discharging into the MS4.

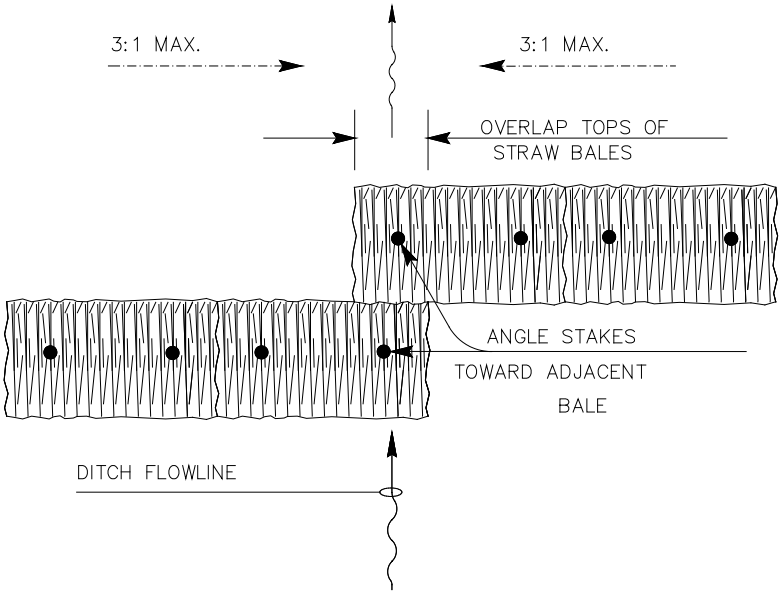
D. Projects With A Larger Common Plan of Development. Contractor (Operator) shall comply with the Large Project requirements listed in Paragraph 3.01.A of this specification on those projects that will disturb one (1) or more acres, but less than five (5) acres, and are part of larger common plan of development that will disturb five (5) or more acres.

3.02 CLEAN-UP

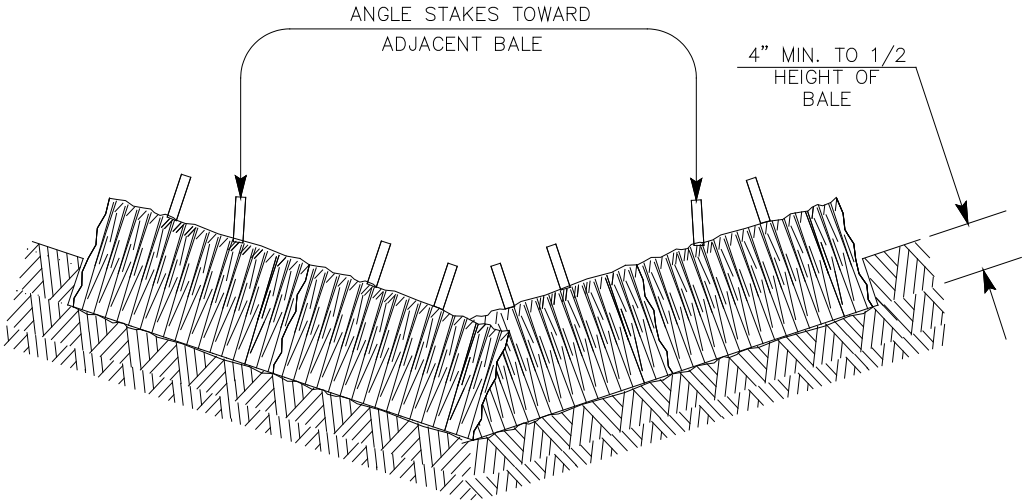
A. Once the site is permanently stabilized, remove and dispose of all temporary erosion control devices unless otherwise approved by Engineer.

3.03 DRAWINGS

(See Attached)

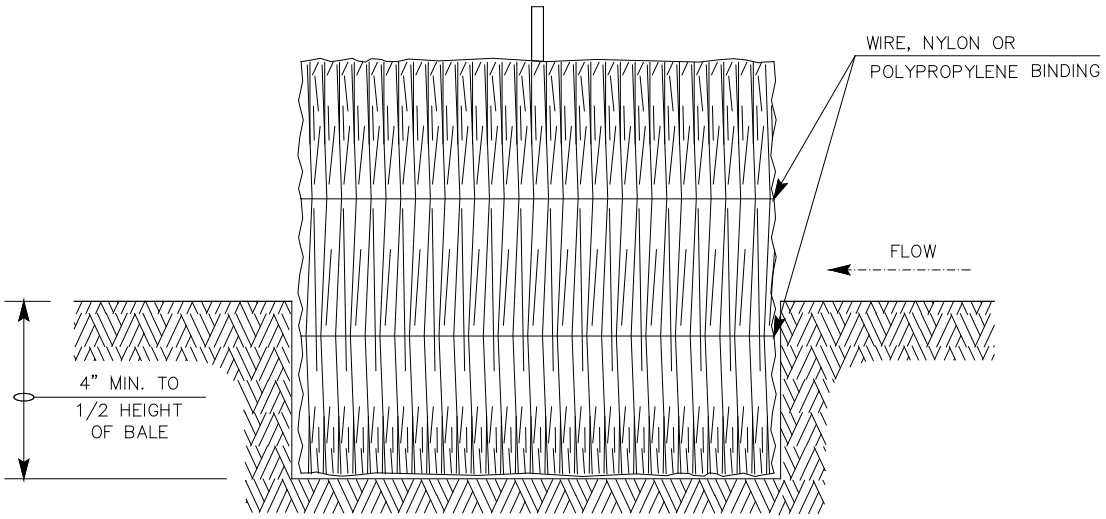


PLAN VIEW

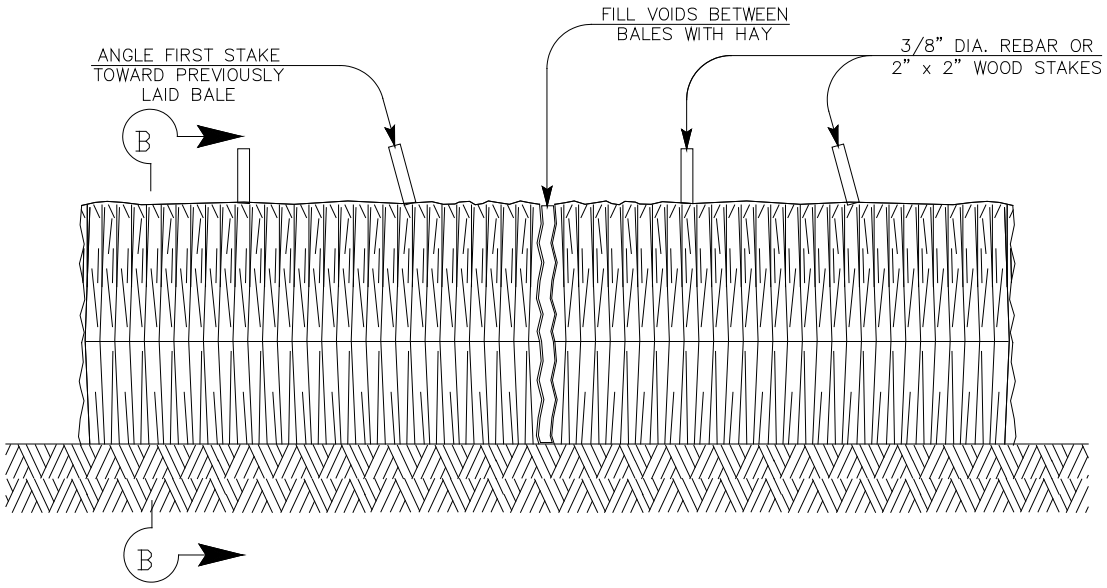


PROFILE VIEW

BALED STRAW FOR EROSION CONTROL



SECTION B–B



GENERAL NOTES

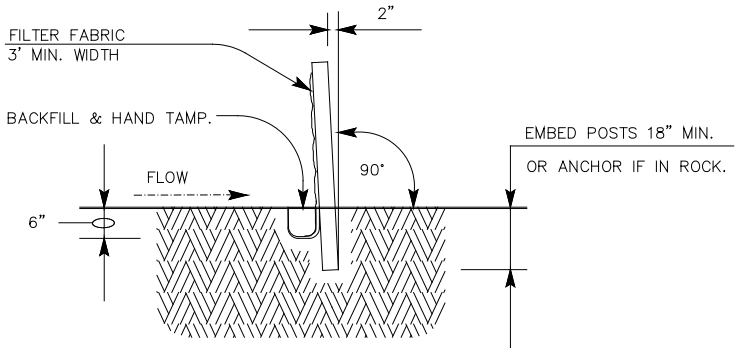
1. STRAW BALES SHALL BE A MINIMUM OF 30" IN LENGTH AND WEIGH A MINIMUM OF 50 LBS.

2. STRAW BALES SHALL BE BOUND BY EITHER WIRE OR NYLON OR POLYPROPYLENE STRING. THE BALES SHALL BE COMPOSED ENTIRELY OF VEGETABLE MATTER.

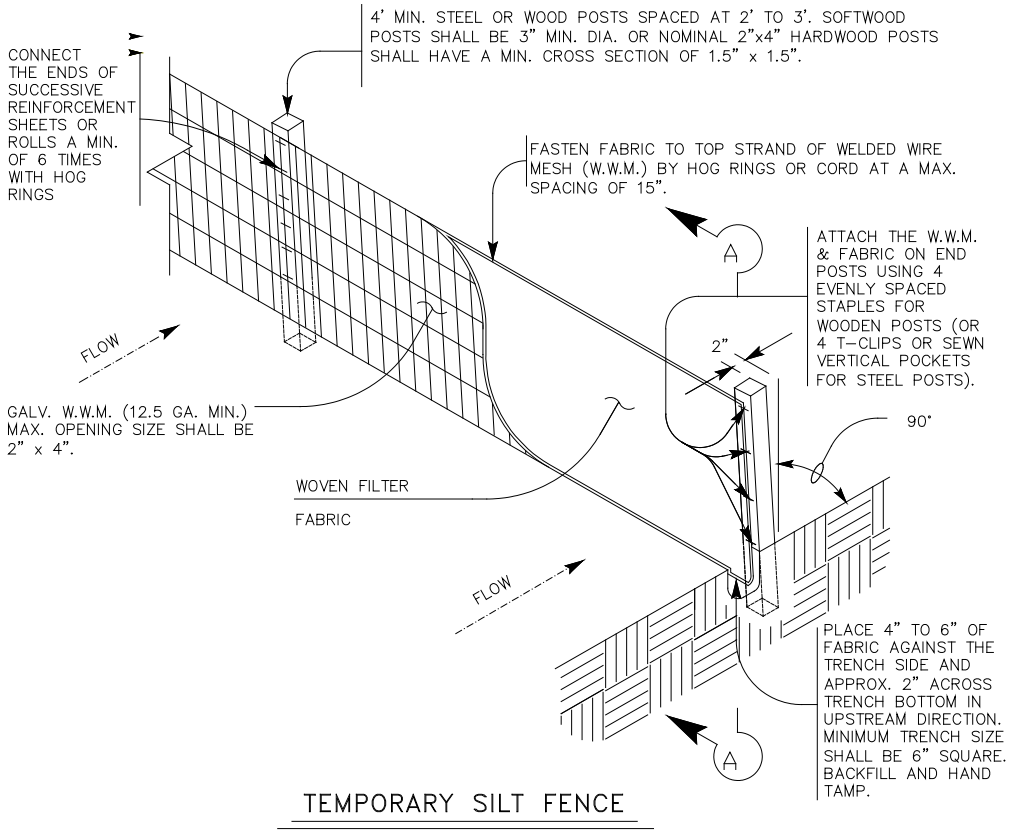
3. STRAW BALES SHALL BE EMBEDDED IN THE SOIL A MINIMUM OF 4" AND WHERE POSSIBLE 1/2 THE HEIGHT OF THE BALE.

4. STRAW BALES SHALL BE PLACED IN A ROW WITH ENDS TIGHTLY ABUTING THE ADJACENT BALES. THE BALES SHALL BE PLACED WITH BINDINGS PARALLEL TO THE GROUND.

5. STRAW BALES SHALL BE SECURELY ANCHORED IN PLACE WITH 3/8" DIA. REBAR OR 2" x 2" WOOD STAKES, DRIVEN THROUGH THE BALES. THE FIRST STAKE SHALL BE ANGLED TOWARDS THE PREVIOUSLY LAID BALE TO FORCE THE BALES TOGETHER.



SECTION A–A



TEMPORARY SILT FENCE

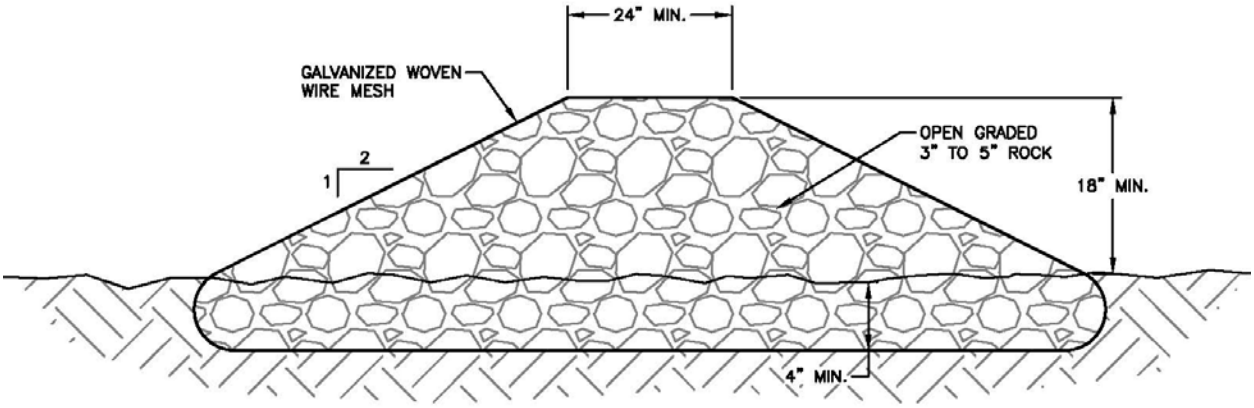
NOTES:

1. THE ROCK FILTER DAM LENGTH AND LOCATION SHALL BE AS INDICATED ON THE SW3P PLANS.

2. SIDE SLOPES SHOULD BE 2:1 OR FLATTER. DAMS WITHIN A SAFETY ZONE SHALL HAVE SIDESLOPES OF 6:1 OR FLATTER.

3. ROCK FILTER DAM SHALL BE SECURED WITH 20 GAUGE GALVANIZED WOVEN WIRE MESH WITH 1" DIAMETER HEXAGONAL OPENINGS. THE AGGREGATE SHALL BE PLACED ON THE MESH TO THE HEIGHT & SLOPES SPECIFIED. THE MESH SHALL BE FOLDED AT THE UPSTREAM SIDE OVER THE AGGREGATE AND TIGHTLY SECURED TO ITSELF ON THE DOWNSTREAM SIDE USING WIRE TIES OR HOG RINGS. IN STREAM USE THE MESH SHOULD BE SECURED OR STAKED TO THE STREAM BED PRIOR TO AGGREGATE PLACEMENT.

4. EMBED ONE FOOT MINIMUM INTO SLOPES.



SECTION

ROCK BERM DETAIL

END OF SECTION 31 25 13

SECTION 31 31 16 - TERMITE CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Soil and wood treatment with termiticide.

B. Related Sections:
   1. Division 31 Section "Earth Moving."

1.03 SCOPE

A. Furnish and install a chemical barrier to afford the structure protection from termites and other common ground insects.

B. Comply with all applicable regulatory and environmental requirements.

1.04 SUBMITTALS

A. Product Data: For each type of termite control product.
   1. Include the EPA-Registered Label for termiticide products.

B. Qualification Data: For qualified Installer.

C. Product Certificates: For termite control products, from manufacturer.

D. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
   1. Date and time of application.
   2. Moisture content of soil before application.
   3. Termiticide brand name and manufacturer.
   4. Quantity of undiluted termiticide used.
   5. Dilutions, methods, volumes used, and rates of application.
   6. Areas of application.
   7. Water source for application.

E. Warranties: Sample of special warranties.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located, and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.07 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
   1. Warranty Period: Five years from date of Substantial Completion.

1.08 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.01 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume

and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, provide the following:
   a. BASF Corporation, Agricultural Products; Termidor.
   b. FMC Corporation, Agricultural Products Group; Prevail.
2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.03 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.04 APPLYING SOIL TREATMENT

A. Apply toxicant to soil in accordance with manufacturer's recommendation. The quantities described in the paragraph are minimums and shall be adjusted as deemed necessary by the treatment agency to provide the required protection.

B. Under all building slabs apply treatment at a ratio of one and a half (1-1/2) gallons per 10 sq. ft., prior to placing of vapor barrier.

C. Apply to a depth of 1 ft. and to a width of one foot along each side of the foundation walls and around piers where applicable around utility openings for pipes, conduits or other slab penetrations at a rate of 4 gallons per 10 lineal feet. Chemical shall be mixed with soil as it is being placed in the trench.
   1. The guarantee shall state that the application was made at the concentration, ratio, and methods which comply with these Specifications.
   2. Re-treatment upon evidence of subterranean termite activity, shall be at no charge to the Owner and in accordance with accepted trade practice.

D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
   1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
   2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
   3. Masonry: Treat voids.
   4. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

G. Post warning signs in areas of application.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.05 CLEAN UP

A. Upon completion, remove debris related to this work from the site.

END OF SECTION 31 31 16

SECTION 31 50 00 - EXCAVATION SAFETY

PART 1- GENERAL

1.01 SUMMARY

A. This section covers the minimum requirements and responsibilities of the Contractor for excavations and shoring/safety of same.

1.02 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.03 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. OSHA - Occupational Safety and Health Administration, 29CFR, Part 1926

1.04 SYSTEM DESCRIPTION

A. The Contractor shall shore or otherwise protect all excavations from cave-ins, protect employees from exposure to vehicular traffic, falling loads, hazardous atmospheres, water accumulation and unstable structures in and adjacent to excavations and provide acceptable means of access to and egress from excavations. Notwithstanding these suggestions, the Contractor is solely responsible for the safety of his employees and the general public as they interface with this construction project.

1.05 SUBMITTALS

A. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed.

B. The Contractor shall furnish an excavation or trench safety plan for any excavation exceeding twenty foot (20') depth. The safety plan must be signed and sealed by a Texas licensed professional engineer.

1.06 QUALITY ASSURANCE

A. Excavation safety system shall meet the current standards established by OSHA, 29CFR, Part 1926, Subpart P-Excavations.

B. Any construction not in accordance with OSHA regulations may not be eligible for payment and delays in construction to bring the project into OSHA regulations will not be the responsibility of the Owner or the Engineer.

1.07 PROJECT/SITE CONDITIONS

A. Contractor shall develop and implement an excavation safety program based on the actual conditions encountered on the project.

PART 2 - PRODUCTS

(Not used.)

PART 3 - EXECUTION

A. Contractor has the sole responsibility for providing an adequate excavation safety system. The Contractor agrees that neither the Owner nor the Engineer has such responsibility and Contractor shall not rely on the Owner or the Engineer or any of their representatives for inspection, design, supervision, construction or any other aspect of excavation safety.

END OF SECTION 31 50 00

SECTION 32 13 13 - CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This section gives requirements for Portland cement concrete pavement, with or without curbs, on a prepared subgrade and/or other base material.

1.02 RELATED SECTIONS

A. Section 31 23 16.19 - Excavation, Backfilling, and Compacting for Pavement

B. Section 03 30 53 - Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ACI - American Concrete Institute
   2. ASTM - American Society for Testing of Materials
   3. AASHTO - American Association of State Highway and Transportation Officials
   4. TxDOT - Texas Department of Transportation - Standard Specifications for Construction of Highways, Streets and Bridges
   5. CRSI - Construction Reinforcing Steel Institute

1.05 QUALITY ASSURANCE

A. It shall be the responsibility of the Contractor to produce concrete pavement of the strength, durability, workability and specified finished; furnish representative materials for specimens in quantities required by the testing laboratory; take samples of materials for testing; check proportions of mix and immediately notify the Engineer if proportions appear improper in any respect. The Contractor shall comply with all testing laboratory findings and the Engineer's decisions in reference to these findings. The Contractor shall pay for the redesign of the concrete mix due to a change in the source of materials.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Reinforcing Steel. All steel reinforcement shall be stored above the ground on platforms, skids or other supports as approved by the Engineer. Reinforcement shall be stored in a location such that it is protected from mechanical injury and rust. When placed in the work, steel reinforcement shall be free from dirt, scale, rust, oil, paint and other material.

B. Miscellaneous Materials. All miscellaneous materials that are to be used to properly execute the work required to construct concrete pavement shall be stored and handled in accordance with the manufacturer's instructions and/or in a manner is acceptable to the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Concrete. Provide concrete in accordance with the applicable provisions of Section 03 30 53, Cast-In-Place Concrete. Concrete pavement shall be "Normal Weight Structural Concrete" and shall have a minimum twenty-eight (28) day compressive strength of 3,500 pounds per square inch (psi).

B. Reinforcing Steel and Related Materials. Provide the following steel reinforcing items and related materials:

1. Reinforcing Steel. All steel reinforcing shall be open hearth, new billet steel manufactured in the United States and conforming to ASTM A615. All bars shall be Grade 60 with a minimum yield strength of 60,000 pounds per square inch (psi). Unless otherwise shown on the Drawings, all deformed steel reinforcing shall be #4 bars. All smooth steel reinforcing for doweling expansion and contraction joints shall be plain steel bars conforming to ASTM A-306, Grade 70, shop cut to length, straight, clean and free of rust or scale.
2. Supports for Reinforcing. Supports for reinforcing bars shall be the correct type as intended and represented by the manufacturer. Bar supports shall be uniform high density polyethylene or fiberglass reinforced plastic and conform to CRSI Class 1, Maximum Protection. Concrete blocks or brick will not be accepted.
3. Tie Wire. Use 18-gauge annealed steel for tie wire.

C. Expansion Joints. In addition to dowels, provide the following material for expansion joints:

1. Joint Filler Material. Filler material shall be preformed expansion joint filler of the bituminous type which conforms to the requirements of ASTM D1751. Unless otherwise shown on the Drawings, the thickness of the

filler material shall be 3/4-inch.

2. Joint Sealing Compound. Joint sealing compound shall conform to the requirements of ASTM C-920, Type S, Grade P or NS.
3. Backer Rods and Backing Materials. Provide a compressible type material such as closed-cell, resilient foam or sponge rubber stock of vinyl, butyl or neoprene, or expanded polyethylene or polyurethane. The diameter of the backer rod shall be at least twenty-five (25) percent larger than the joint reservoir and shall be capable of holding the fluid joint sealing compound in open joint in place. Backer rods shall be of such a type that it will not bond to the joint sealing compound.
4. Sleeves. Sleeves for expansion joints shall be 26-gauge steel or PVC tubes which are capped at one end. Sleeves shall be in accordance with ASTM A120.

D. Forms. Provide metal or wooden forms to construct the concrete pavement. Wooden forms shall be of sound 2 X material of a depth equal to the required edge thickness of the pavement, free from warps, twists, loose knots, splits or other defects and constructed to provide a straight edge on the concrete. Metal forms shall be of an approved shape and section with a depth of the form equal to the edge depth of the pavement. The metal forms shall be free from warps, bends and kinks and shall be constructed to provide a straight edge on the concrete.

PART 3 - EXECUTION

3.01 PREPARATION

A. General. In addition to any instructions specified herein, the preparations detailed in Section 03 30 53, Cast-In-Place Concrete, paragraph 3.01, shall also apply here as if written in their entirety. This includes, but is not limited to, the minimum twenty-four (24) hour notification that shall be given to the Engineer before any concrete is placed.

B. Subgrade Preparation and Protection. Excavate, prepare, shape, and compact the subgrade to the grades and densities shown on the Drawings and in accordance with applicable section. Subgrade shall be wetted sufficiently to minimize moisture loss from the concrete to the subgrade. Water puddles or muddy areas will not be allowed. Maintain the subgrade in a smooth, compacted condition at the proper grades until the concrete has been placed. No ready mix trucks or other equipment shall be allowed to operate within the forms unless clearance or other job conditions will not allow operation from outside the forms. If trucks must operate between the forms, the subgrade shall be protected from damage by use of runways. Any ruts or irregularities in the subgrade caused by equipment or by trucking material shall be corrected by second rolling or hand tamping.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Placing of Reinforcing Steel. Reinforcing steel to be used in the construction of concrete pavement shall be placed in a criss-cross pattern such that the longitudinal steel is parallel and the transverse steel is perpendicular to the centerline of the pavement section; and have twelve (12) inch lap splices when joining two (2) individual lengths of rebar together. Lap splices in adjacent bars shall be staggered such that splices do not occur in the same location in adjacent bars and, where possible, use full length reinforcing steel for executing the work. At interior corners and at corners of block outs, place three – 36 inch long diagonal bars at 6 inch spacing at each corner to minimize diagonal cracking. Steel reinforcing bars shall be tied together at all points of intersection with the specified tie wire and be securely held in place with bar supports (chairs), or other acceptable methods, during the placement of the concrete.

B. Placement of Concrete. Place and compact concrete for the construction of concrete pavement in accordance with the applicable provisions for "Normal Weight Structural Concrete" outlined in applicable section.

C. Concrete Pavement Finish. The pavement shall be struck-off and consolidated with mechanical finishing machines or by hand-finishing methods. Associated concrete curbs shall be given the same finish as the concrete pavement.

1. Mechanical Finishing. Texturing equipment shall be per TxDOT Item 360:
    a. Carpet Drag: Provide a carpet drag mounted on a work bridge or a moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications. Use an artificial grass-type carpet having a molded polyethylene pile face with a blade length of 5/8 in. to 1 in., a minimum weight of 70 oz. per square yard, and a strong, durable, rot-resistant backing material bonded to the facing.
    b. Tining Equipment. Provide a self-propelled transverse metal tine device equipped with 4-in. to 6-in. steel tines and with cross-section approximately 1/32 in. thick by 1/12 in. wide, spaced at 1 in., center-to-center. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas or, when permitted, in emergencies due to equipment breakdown.
2. Hand Finishing. The concrete shall be consolidated by appropriate vibratory tools and screeded to the required grade. The surface finish shall

be a broom finish or finish by other equipment transverse to the streed/road equivalent to that produced by mechanical finishing described above.

D. Curing of Concrete. All concrete pavement shall be cured for a period of not less than seventy-two (72) hours. Curing of all exposed concrete surfaces shall begin immediately after the completion of the finishing operations. The following are acceptable methods for curing concrete:

1. Polyethylene Film Curing. After completion of the finishing and after initial set of the concrete, apply a fine spray of water to the concrete and cover it with a polyethylene film. Place and secure polyethylene film in direct contact with the concrete surface such that an airtight seal is maintained for the entire duration of the specified curing time. Contractor is responsible for preventing and repairing any damage to the polyethylene film during the entire curing time. The polyethylene film blankets are subject to the approval of the Engineer. The film blankets shall be rejected at any time when, in the opinion of the Engineer, the required airtight seal is not maintained.
2. Curing Compound. After completion of the finishing operations and the disappearance of the free surface moisture, uniformly spray the concrete surface with an approved curing compound. The curing compound membrane shall be applied in accordance with the manufacturer's instructions. If water drops do not bead or water soaks into concrete after application of the curing compound, a full additional coat of compound shall be applied. Contractor is responsible for preventing and repairing any damage to the curing compound membrane during the entire duration of the specified curing time.

E. Joints. All joints shall be of the types shown and at the location and spacing indicated on the Drawings. All joints shall be constructed true to line with their faces perpendicular to the pavement. Transverse joints shall be at right angles to the centerline of the pavement and shall extend the full width of the slab. Longitudinal joints shall be installed parallel to the centerline of the pavement. Transverse joints in succeeding lanes shall be placed in line with similar joints in the existing pavement. All joints shall be so prepared, finished and cut to provide a groove of sufficient width and depth to receive and retain joint sealing material.

1. Construction Joints. Transverse construction joints of the types shown on the Drawings shall be placed wherever the placing of concrete is suspended for a period of more than thirty (30) minutes. These transverse joints, when planned, shall be placed at either an expansion joint or at a contraction joint. The joint shall not be allowed within eight (8) feet of a regularly spaced transverse joint. If the pouring of concrete is stopped and a joint is required in these limits, then it shall not be installed and the fresh concrete shall be removed back to the previously spaced regular joint. Dowel assemblies or other approved load transfer devices shall be installed at the joint as required by the Drawings. Longitudinal

construction joints necessary for lane construction shall be of the dimensions and type shown on the Drawings. These joints shall be either a keyed joint or a butt type joint with dowels. The keyed joint shall be formed by placing a deformed metal plate against the form when the first lane adjacent to the joint is placed. This plate is to be removed with the forms. The edge of the joint shall be finished with an edging or grooving tool and a slot, of the dimensions indicated, shall be formed to receive joint sealing material.

2. Expansion Joints. Transverse and longitudinal expansion joints shall be installed at the location and spacing as shown on the Drawings and shall be installed and finished to provide complete separation of the slabs. The expansion joint material shall be of the preformed type conforming to these specifications. If joints are to be equipped with dowels, they shall be at the spacing and location indicated on the Drawings. They shall be firmly supported in place, accurately aligned parallel to the pavement grade and the centerline of the pavement by means of dowel support which will remain in the pavement so that the dowels are not displaced during construction. One-half of each dowel shall be painted with rust preventative paint and greased with an approved lubricant and, in expansion joints, shall be equipped with the specified tight fitting 26-gauge steel or PVC sleeve. The sleeve shall provide for an unobstructed expansion space of one (1) inch to permit dowel movement. The closed end of the sleeve shall be watertight. In the construction of transverse joints in pavement with integral curbs, special care shall be taken to see that all transverse joints extend continuously through the pavement curb. When dowels are not specified, the thickness of the concrete at these joints shall be increased by at least twenty-five (25) percent of the normal pavement thickness to the nearest inch, but not more than two (2) inches. This increased thickness shall slope to the normal pavement thickness in not less than five (5) feet from the joint or to the nearest joint. Following the placement of the concrete, all excess concrete shall be cleaned from the top of the expansion joint material, and before opening to traffic, this space shall be swept clean and filled with a joint sealing compound as specified herein. Following the removal of the forms, any concrete bridging the joint space at the ends shall be removed.

3. Contraction Joints. Transverse contraction joints shall be of the sawed or formed dummy groove type and shall be at the locations and spacing and of the dimensions shown on the Drawings. The joints shall consist of a groove in the top of the slab sawed in the hardened concrete or formed in plastic concrete. Saw cut contraction joints shall be made using a diamond tipped blade to the depth shown on the Drawings as soon as sawing can be done without damage to the pavement, regardless of time of day or weather. Saw joints must be completed within 8 hours of concrete placement. Use a chalk line, string line, sawing template, or other acceptable methods to provide a true joint alignment. Provide enough saws, including back-ups, to match the paving production rate to provide

sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to provide timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hr. of curing.

When formed, the groove shall be true to line and shall be uniform in width and depth. The sides of the groove shall be finished even and smooth with an edging tool. Reinforcing steel shall be continued through all contraction joints. Dummy groove contraction joints shall extend vertically downward 1/4 of the slab depth from the surface and prior to opening for traffic shall be cleaned and filled with the specified joint sealing material. Longitudinal contraction joints shall be of the deformed metal strip type located according to Drawings.

F. Opening to Traffic. The Contractor shall erect and maintain barricades to keep public and construction traffic from traveling on the newly placed concrete pavement. Prior to allowing traffic on the pavement, all joints shall first be sealed, the pavement cleaned, and earth placed against the pavement edges. If approved by the Engineer, traffic will be allowed on the pavement after the concrete has been in place for ten (10) days, but will be limited to vehicles with a gross weight of 14,000 pounds or less. After fourteen (14) days, if acceptable to the Engineer, the pavement shall be opened to all traffic except any equipment not licensed for operation on public highways. The opening of the pavement to traffic shall in no way relieve the Contractor from his responsibilities for the work as stated in the Contract and any Conditions thereto.

3.03 REPAIR / RESTORATION

A. Any pavement which does not meet the specified thickness.

3.04 FIELD QUALITY CONTROL

A. General. Field quality control shall be in accordance with the applicable provision of applicable section, and any other provisions specified herein.

B. Cores. The thickness of the completed pavement will be determined prior to final acceptance by the measurement of cores taken at such points as the Engineer may select. These cores, if taken, shall be at the rate of at least one (1) core for each five-hundred (500) square yards of pavement.

END OF SECTION 32 13 13

SECTION 32 14 16 – BRICK UNIT PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Supply and install brick pavers.
   2. Supply and place all accessory items as required by the contract.

B. Related Sections include the following:
   1. Division 32 Section "Concrete Paving."

1.03 PRODUCT HANDLING

A. Pavers shall be delivered and unloaded at job site on pallets and bound in such a manner that no damage occurs to the product during handling, hauling and unloading.

1.04 QUALITY ASSURANCE

A. The installer/contractor must have related experience in the installation of brick pavers.

1.05 SUBMITTALS

A. Submit sample of paver color and/or type showing full range of color.

PART 2 - MATERIALS

2.01 PAVERS

A. Brick Pavers: Handicap detectable warning pavers (2 ¼" x 7 5/8" x 3 5/8") manufactured by Endicot. Colors as selected by Architect from manufacturer's standard line.

B. Geo-textile: Provide geo-textile as indicated in drawings and as recommended by paver manufacturer.

2.02 VISUAL INSPECTION

A. All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or performance of the construction. Minor cracks incidental to the usual methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

2.03 SAND LAYING COURSE

A. The sand laying course shall be well graded clean washed sharp sand with 100% passing a 3/8" sieve size and a maximum of 3% passing a No. 200 sieve size; this is commonly known as manufactured concrete sand, limestone screening or similar. DO NOT USE MASON SAND.

B. The sand laying course should be the responsibility of the paving stone installer.

PART 3 - EXECUTION

3.01 CONSTRUCTION OF THE SAND LAYING COURSE

A. The finished concrete base shall be approved before the placement of the sand laying course.

B. The uncompacted sand laying course shall be spread evenly over the area to be paved and then screeded to a level that will produce 1" thickness when the paving stones have been placed and vibrated. Normally, it is a good practice to have final elevation of paving stones slightly higher than adjacent curb, gutters, other paving, to allow for any minor settling that may occur within the base.

C. Once screeded and leveled to the desired elevation, this sand laying course shall not be disturbed in any way.

3.02 LAYING OF PAVERS BRICK

A. The paving bricks shall be laid in a pattern where noted or as shown on Drawings.

B. The paving bricks shall be laid in such a manner that the desired pattern is maintained and the joints between the bricks are as tight as possible.

C. String lines should be used to hold all pattern lines true.

D. The gaps at the edge of the paver surface shall be filled to provide a tight fit. Cutting shall be accomplished to leave a clean edge to the traffic surface using a masonry saw. Whenever possible, no cuts should result with a paver less than 1/3 of original dimension.

E. Paving bricks shall be vibrated into the sand laying course using a vibrator capable of 3,000 to 5,000 pounds compaction force with the surface clean and joints open.

F. After vibration, clean masonry type sand and containing at least 30% of 1/8" (3mm) particles shall be spread over the paving surface, allowed to dry, and vibrated into joints with addition vibrator passes and brushing so as to completely fill joints.

G. Surplus material shall then be swept from the surface or left on surface during construction time to insure complete filling of joints during initial use. This sand may provide surface protection from construction debris.

END OF SECTION 32 14 16

SECTION 32 17 00 - PAVEMENT SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Parking barriers.
   2. Precast concrete curbs.
   3. Striping & directional paint markings.
   4. Detectable Warning Mats.
   5. Precast Concrete Bollards.
   6. Precast Concrete Bollard Caps for Steel Pipe Bollards.

B. Related Sections include the following:
   1. Division 03 Section- "Concrete".
   2. Division 32 Section - "Paving".
   3. Division 32 Section - "Unit Paving".
   4. Division 32 Section – “Parking Pavement Markings”

1.03 GENERAL

A. Furnish all labor, materials, services, equipment and appliances required for pavement specialty work indicated on the drawings and specified herein.

1.04 JOB CONDITIONS:

A. Condition of pavement: Clean, dry and cured minimum amount of time as recommended by striping paint manufacturer.

1.05 SUBMITTALS

A. Submit manufacturer's literature to the Architect for approval. Literature shall show compatibility of product proposed for use with paving surface to which product is to be applied.

B. Samples for initial selection: Manufacturer's standard selector samples or printed material showing accurate color rendition, for warning mats and concrete bollards.

C. Shop Drawings: Show footing design, and attachment details of pavment specialties to adjacent construction. Include dimensioned site plan for location of bollards and detectable mats, coordinated with Contractor's field-verified dimensions.

1.06 COORDINATION OF WORK

A. Contractor and subcontractor for work of this section shall be jointly responsible for the coordination of the work specified herein, including but not limited to:
   1. Fire Lanes: Coordinate with all governing authorities to determine exact requirements (whether or not shown on the drawings). Fire lane marking, if required, is part of the work of the base contract.

2. Handicapped Parking Spaces: Coordinate with all governing authorities to determine exact requirements (whether or not shown on the drawings). Special marking, if required, is part of the work of the base contract.
3. Colors: Coordinate color requirements with all governing authorities, use only acceptable colors. Colors specified herein shall be used, if acceptable.
4. Notification: Notify the Owner of any required variation from the drawings resulting from coordination.

1.07 PROTECTION

A. Protect newly painted surfaces from damage by vehicles during the time required for paint to harden sufficiently to withstand traffic. Any damage to newly painted markings due to the paint subcontractor's failure to provide adequate protection shall be repaired by him at no additional cost to the Owner.

1.08 GUARANTEE [AND WARRANTIES]

A. Pavement Markings:
   1. Any work found to be defective due to poor workmanship or defective materials within a 60-day evaluation period from Substantial Completion will immediately be replaced at no additional cost to the Owner. A new 60-day evaluation period will commence upon repair. Contractors One-Year corrective period shall also be enforced as a remedy by Owner for continued deteriorating paint installation.
   2. Indications of defective work for the purpose of this guarantee include poor adhesion to the pavement surfaces, checking, cracking, peeling and discoloration. This shall not be construed to include wear, damage or discoloration caused by traffic, erosion or from normal exposure to the elements.

B. Concrete Bollards: Manufacturer's standard 1-year warranty against manufacture defects.

C. Warning Mats: Manufacturer's standard 5-year warranty covering defects in materials and workmanship.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Parking Barriers: Precast concrete, semicircular or beveled square in cross-section 6" high x 8" wide x 6'-0" long with holes for minimum anchoring dowels.

B. Striping & Directional Marking Paint: Acrylic parking lot and/or street marking paint, recommended by manufacturer for type of surface.
   1. Paint type: Acrylic, water-borne pavement marking paint conforming to Texas Dept. of Highways Special Specification Traffic paint.
   2. Color:
      a. General Use Striping, Directional Marking, & H.C. Marking: White – Sherwin Williams Setfast Acrylic Waterborne Traffic Marking Paint product No. TM 226.
      b. At line striping indicated in drive aisles or roadways that is located between opposite directions of traffic, use traffic yellow.
      c. Fire Lane Striping: Red – Sherwin Williams Setfast Acrylic Traffic Marking Paint product No. TM 5628, or as required per city code. Fire lane striping shall have lettering stenciled in white at 20' intervals, to read: “NO PARKING-FIRE LANE”, or as required by local fire codes and regulatory authorities.

PART 3 - EXECUTION

3.01 PREPARATION

A. Removal of existing pavement markings: Where indicated in plan, and as inferred by new striping shown in areas of existing striping, remove existing striping completely by sand blasting or other method acceptable to Engineer and that will cause negligible damage to existing paving and surface texture. Power wash and clean paving to prepare surface for new pavement markings in accordance with paint manufacturer's recommendations.

B. New concrete surfaces will be allowed to cure for a period of not less than 11 days before application of marking materials.

C. Dust, clay, silt and excess sand will be removed (by sweeping) from the pavement to be marked before application of paint.

D. Prior to beginning work, confirm requirements of regulatory authorities for pavement markings including colors. Where TxDOT or other authority has jurisdiction, confirm their requirements. Locate the fire lane striping on horizontal paving surface or on entire concrete curbs as required by local authorities. Where fire lanes are painted in a radiused arc across drive aisle, confirm acceptable radius dimension with local authorities for fire lane striping.

3.02 INSTALLATION:

A. Equipment: Spray mechanism capable of applying paint at the rate specified at an even and uniform thickness, with clear cut edges. Mechanism shall be operated by means of quick opening and closing valves conveniently located.

B. Striping & Marking:
   1. Where pavement is trowel or wood float finish concrete, lightly sandblast immediate area to receive striping prior to application of paint.
      a. Rough broom finish areas will not require sand-blasting.
   2. Apply paint in accord with manufacturer's written instructions. Apply at a rate of one gallon spread evenly over an area of 105 SF± five square feet and a wet film thickness of 0.015 inch (15 mils.).
   3. Paint 4" wide lines in patterns and spacing as shown on drawings. Width of the lines shall be within a tolerance of one-half inch. The centerline of marking shall not deviate more than one-half inch laterally from a straight line at any point.
   4. Parking Striping:
      a. Painted lines: 4" wide, generally 20' long, and spaced approximately 9' O.C. except where noted or local authorities require otherwise.
      b. If the overall space divides equally into slightly larger spacing than 9', individual spaces should be increased equally, but should not in any case be less than 9' O.C., unless noted otherwise on drawings.

C. Parking Barrier: Drill hole through pavement surface for steel rods to secure barrier in place. Barrier shall be centered between paint stripes. Minimum 2 #5 rods per barrier extended below paving surface and countersink 1/2" below top surface of barrier. At asphalt paving, extend 24" below paving.

D. Detectable Warning Mats: Install mats per manufacturer's installation instructions for indicated paving substrate(s).

E. Pre-Cast Concrete Bollards: Install per manufacturer' installation instructions and as follows:
   1. Coordinate footing locations with the work of other trades that may be affected.

2. Locate footing locations and achoring inserts accurately per approved shop drawings and manfacturer's requirements. Maintain alignments as indicated in Drawings.
3. Provide concrete footing with cast-in anchors or dowels as required per manufacturer's recommendations, or as detailed in Drawings. Or if footing is not otherwise recommended by Manufacturer or detailed in Drawings to minimum size of 12" diameter x 3' deep with #3 reinforcing in two vertical "stirrups" at 90 degrees and to each other and (3) #3's horizontal at equal spacing. Concrete used for footing shall be equal to or exceeding precast concrete bollard concrete strength. Footing to be installed to manufacturer's requirements if more stringent.
4. If paving installer is other than bollard installer, coordinate all requirements with concrete paving and footing installer, prior to forming concrete paving.

F. Pre-Cast Concrete Bollard Caps for Pipe Bollards: Install according to Manufacturer's installation instructions.

3.03 CLEANING

A. Any spilled paints shall be cleaned from the paved areas to the satisfaction of the Owner. Keep the premises clean at all times.

B. Paint, empty containers, and other materials or equipment shall not be stored or allowed to accumulate on, or near the paved areas.

C. Upon completion of work of this section remove related debris from premises.

END OF SECTION 32 17 00

SECTION 32 17 23.16 - PARKING PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

A. This specification describes the procedures and product for the marking (painting) of pavement for parking spaces, crosshatched handicapped aisles, crosshatched crosswalks, loading zones, and other markings shown on the Drawings. Included is the installation of handicapped signs as shown on the Drawings. A handicapped sign is to be placed at each handicapped parking space. For van accessible spaces, a van accessible sign is required and is to be mounted on the same pole as a handicapped sign.

1.02 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.03 SUBMITTALS

A. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pavement marking paint:
   1. White - Sherwin Williams Setfast Acrylic Waterborne Traffic Marking Paint product no. TM 226 or approved equal.
   2. Yellow - Sherwin Williams Setfast Acrylic Waterborne Traffic Marking Paint product no. TM 227 lead free or approved equal.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. All markings shall be applied and surfaces prepared as recommended by the product manufacturer. Stripe width for parking spaces and similar type markings

shall be a minimum of four (4) inches. Diagonal stripes at 45° shall be painted on handicapped access aisles at handicapped parking spaces, on crosswalks, and on pedestrian loading zones. Perpendicular distance between diagonal stripes shall be 36" C-C (48" along the line to which the diagonal line connects).

END OF SECTION 32 17 23.16

SECTION 32 31 19 - DECORATIVE METAL FENCING AND GATES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Provide and install complete metal fencing and gates as shown in Drawings and as herein specified.
   2. Gate operators.

B. Related Sections include the following:
   1. Division 3 Section "Concrete", concrete for footings.
   2. Division 8 Section "Door Hardware" for door hardware installed on ornamental gates.
   3. Electrical, for coordination of conduits and wiring/data cabling to gate operators.
   4. Division 32 Section "Earthwork" for coordination with site grading.

1.03 REFERENCE STANDARDS

A. Safety standard for vehicular gate operators: UL 325

B. Construction standard for automated vehicular gates: ASTM F2200

C. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.04 DEFINITIONS

A. Entrapment Area: An area that has any one dimension that is greater than 4 inches or less than 16 inches where a person or body part can become caught or trapped between an automated gate or component of the gate and any fixed stationary object.

B. Protrusions: Any object less than 9 square inches of cross sectional area attached to the gate, with a surface that extends behind the extreme horizontal planes created by the gate structure members.
   1. Exceptions for certain hardware are allowed by code and reference standards. Contractor shall comply with requirements as part of delegated design.

1.05 QUALITY ASSURANCE AND DELEGATED DESIGN

A. Contractor shall provide delegated design and installation to the requirements of this article. Where provisions are specifically detailed in the Drawings, design components to match the design or appearance as indicated in Drawings, but not to less than the requirements of this article. The heaviest material or most restrictive requirements indicated shall govern.

B. The manufactured fencing system shall be capable of meeting the vertical load, horizontal load, and infill performance requirement for industrial weight fences under ASTM F2408

C. Gate Operator Installer Qualifications: Where required by state law or other authority having jurisdiction, installer shall be a licensed automated vehicular gate operator installer.

D. Design, construct, and install automated gates to meet the requirements of UL 325, ASTM F2200, and to the requirements of local code enforcement having jurisdiction. Automated gate systems that do not meet the requirements of these systems shall not be allowed.

1. In the event of conflict between gate configurations indicated in the Drawings, and the requirements of codes and reference standards, inform Architect of all conflicts to confirm resolution.

E. Delegated Design Criteria for motorized gates and operators: Design gates to meet reference standards, and the following:
   1. Protrusions: Design and install gates without protrusions, except for hardware allowed to protrude as specifically permitted by code and reference standards.
      a. Vertical and Bottom Edges: Protrusions at leading and tailing edges of gates, and at bottom edge of gates, shall not exceed 1/2 inch and shall be smooth on all surfaces with no sharp edges.
      b. Protrusions outside of the vertical plane are permitted where protrusions are seven (7) feet or more above grade throughout the gate's range of operation.
      c. Gate locks, positive stops, and wheels are not considered to be protrusions on sliding gates.
   2. Entrapment: Design and install gates and fencing such that there are no entrapment areas. Where entrapment areas are unavoidable due to configuration of the gate, provide entrapment protection devices.
      a. Provide protection devices compliant with UL 325. Provide non-contact sensors where possible.
      b. Loop detectors are not entrapment protection devices. Protection devices must be capable to detect presence of human beings in the entrapment area(s).
   3. Reach-through Prevention: Openings in the gate shall be designed, guarded or screened from the bottom of the gate to the top of the gate (or to a minimum of 72 inches above grade where indicated in Drawings), to prevent a 2-1/4" sphere from passing through openings anywhere in the gate, and that portion of fencing that the gate covers in the open position.
   4. Controls location: Card Readers, keypads, or similar control devices shall be located at least 6' from moving parts of the gate and in such a way that users cannot reach over, under, around, or through the gate to activate a control.
   5. Unlevel Gates: Gates shall be designed and installed such that movement will not be initiated by gravity when an automated operator is disconnected. Provide counterbalance mechanisms as required.
   6. Fall-over Prevention for Sliding Gates: Design and install gates so that they cannot fall over more than 45 degrees from the vertical plane when detached from the supporting hardware. Provide catcher posts or brackets of adequate strength to resist fall over without bending or deflection of the posts or brackets.
   7. Gate Roller Protection: All exposed rollers shall have guards or covers.
   8. Positive Stops: Sliding gates shall have positive stops to limit travel to the designed fully open and fully closed positions, and shall project no more than that required to perform their intended function.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, and installation instructions for fencing, gates, hardware, operators, and accessories.

B. Shop Drawings: For gates and operators. Include elevations, hardware details and installation details.

C. Informational Submittals: Installer qualifications.

1.07 CLOSEOUT SUBMITTALS

A. Provide copies of operation of maintenance manuals for gate operators and associated control components. Manual should identify part numbers for future maintenance procurement.

B. Copies of actuated warranties. Contractor is responsible for submitting completed warranty documentation to manufacturer, and copies for Owner's warranty binder and O&M manuals.

1.08 HANDLING AND STORAGE

A. Inspect materials upon receipt for damamge. Reject damaged material. Store materials to ensure proper ventilation and drainage and protect against damage from weather, vandalism, and theft.

1.09 WARRANTY

A. Fencing and gate Manufacturer's standard 20 year limited warranty on fence and gate finish.

B. Gate Operators: Manufacturer's standard form 5-year warranty against defects in materials in which Manufacturer agrees to provide repair or replacement of defective parts or units without cost to Owner. Warranty excludes labor costs.
   1. Installer's 5-year guarantee to make repairs due to defects in installation, and including all costs to replace parts found to be defective within the warranty period, at no additional cost to Owner.

PART 2 - PRODUCTS

2.01 FENCING AND GATES

A. Fencing and Swing Gates: Basis of Design: Design for Industrial Weight Ornamental Steel Fence is based on fencing and gates as manufactured by Ameristar Fence Products Inc., P. O. Box 581000, Tulsa, OK 74158-1000, 918-835-0898, 1-800-321-8724, Fax 877-926-3747, www.ameristarfence.com. Subject to compliance with requirements, provide the specified product, or comparable product by Fortress Iron, Master Halco, or by another approved manufacturer.
   1. Montage II ATF Welded Ornamental Steel Fence:
      a. Design: Majestic.
      b. Rail Style: 3-rail fence and gate system with extended picket bottom rail treatment**,** except for flush bottom rail treatment at motorized gates.
      c. Rails: Minimum 1.75" x 1.75" x minimum 0.105" thickness x maximum 8' lengths steel channel.
   2. Fence panels and posts shall conform to the requirements of ASTM A653/A6533M, with minimum yield strength of 45,000 psi. Hot dip galvanized coating designation G-90.
   3. Fence Height and Posts: Minimum fence posts for fence heights as noted in Drawings shall be as follows, or standard minimum sizes as recommended by Manufacturer, whichever is greater:
      a. 4 feet high fence: Minimum 2-1/2" square x 12 gauge.
      b. 6 or 8 feet high fence: Minimum 3" square x 12 gauge.
      c. 10 feet or taller fence: Minimum 4" square x 11 gauge.
   4. Gate Height and Posts: Gates shall be 6 feet high, with minimum post sizes as follows, to match typical fence post size, or standard minimum sizes as recommended by Manufacturer, whichever is greatest:
      a. Gates up to 6' leaf: Minimum 3" square x 12 ga.
      b. Gates over 6' to 10' leaf: Minimum 4" square x 3/16".
      c. Gates over 10' to 16' leaf: Minimum 6" square x 3/16".

d. Gates over 12' leaf and 8' or taller: Minimum 8" square x 1/4".

5. Pickets: 1" square x minimum 14 gauge tubing. Space between pickets shall be less than 4" clear.
6. Post Caps: Weathertight closure caps, as selected by Architect from Manufacturer's standard styles.

2.02 AUTOMATIC VEHICULAR GATES (ALTERNATE 8):

A. Vehicular Cantilever Slide Gates: All industrial ornamental aluminum cantilever gates shall conform to the Ameristar® TransPort II gate system, Masjestic style, manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma. The project gate schedule shall include the following additional information for each cantilever gate included in the project scope: 26' – 0" clear opening with 6'-0" height cantilever slide gate, with square gate posts sized as recommended by manufacturer, or no less than 3" x 3", whichever is greater.

1. Materials. The materials used for cantilever gate framing (i.e., uprights, diagonal braces and pickets or pales) shall be manufactured from ASTM B221 aluminum (designation 6063-T-6) with a yield strength of 25,000 PSI, a tensile strength of 30,000 PSI and a standard mill finish. The TransPort® Fast-Trak™ rails shall be manufactured from ASTM B221 aluminum (designation 6063-T-6) with minimum yield strength of 25,000 PSI, a tensile strength of 30,000 PSI and a standard mill finish.
2. Diagonal bracing and uprights shall be 2" sq. x ¼" aluminum. The design of the top and bottom enclosed track shall conform to the manufacturers 5" x 2" Fast-Trak system. Material for pickets shall be 1" x 1/8" wall aluminum.
3. Internal roller truck assembly shall be self-aligning swivel ball-and-socket type running on four bearing wheels. Internal roller truck assembly shall be affixed to the hanger bracket by means of a 5/8" diameter industrial-grade rod end/center bolt, with a minimum static load rating of 10,000 pounds. Attachment of the center bolt to the truck body shall be by means of a swivel joint to ensure equivalent and consistent loading on all bearing wheels and internal track surfaces throughout the travel of the gate.
4. Welded Wire Mesh (used at motorized gates): 1" hexagonal x minimum 20 gauge wire mesh, or other approved mesh. Finish: black PVC coated.
5. Finish: Manufacturer's standard high performance finish system. Color: Black.

B. System shall include all components and hardware required for a complete assembly.

2.03 2.03 FABRICATION

A. Pickets, enclosed track, uprights and diagonal bracing shall be pre-drilled and labeled for easy assembly. All components shall be precut to specified lengths.

B. Top and bottom rail extrusions shall be mechanically fastened to vertical uprights and reinforced with diagonal braces, as required by drawing.

C. The manufactured components shall be subjected to the Ameristar thermal stratification coating process (high-temperature, in-line, multi-stage, and multi-layer) including, as a minimum, a six-stage pretreatment/wash and an electrostatic spray application of a polyester finish. The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be Black. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

Table 1 – Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 3,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60˚ Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

2.04 FENCE FABRICATION FOR WELDED FENCE SYSTEM

A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.

B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by fusion welding process, thus completing the rigid panel assembly. The process shall produce a virtually seamless, spatter-free good-neighbor appearance, equally attractive from either side of the panel.

C. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Industrial weight fences under ASTM F2408.

2.05 FENCE FABRICATION FOR MECHANICALLY ATTACHED SYSTEM

A. Pickets, rails and posts shall be precut to specified lengths. Rails shall be prepunched to accept pickets. Pickets shall be predrilled to accept retaining rods.

B. Grommets shall be inserted into the prepunched holes in the rails and pickets shall be inserted through the grommets so that predrilled picket holes align with the internal upper raceway of the rails. Retaining rods shall be inserted into each rail so that they pass through the predrilled holes in each picket.

C. Completed panel sections shall be capable of supporting a 600 lb. load applied at midspan without permanent deformation. Panels shall be biasable to a 25% change in grade.

2.06 MANUAL SWING GATE FABRICATION

A. Manual Swing Gates fabricated with minimum 1.75"x14 ga double channel rail, 2" square x 11 ga gate ends, and 1" square x 14 ga intermediate pickets. Gates shall have minimum 1.75"x14 gauge intermediate uprights at not more than 6' on center. All rail and upright intersections shall be joined by welding. All picket and rail intersections joined by welding. Gusset plates welded to upright and rail intersections. Provide cable truss for gates 6 feet or wider.
   1. Provide 5' wide man gates unless otherwise noted.
   2. Hinges: Heavy duty offset hinges, non-lift off type, of size and and material to suit gate size and to allow opening and closing without binding. Hinge to allow 180 degree swing unless otherwise noted.

a. Provide minimum of three hinges for gates 8' tall, minimum four hinges for gates 10' or taller.
b. Provide minimum of three hinges for gate leafs wider than 5'.

3. Latch and Lock: Provide gates with reinforcment and miscellaneous steel shapes as required to receive door hardware. Provide manufacturer's standard strike and latch with padlock hasp.

2.07 SLIDE GATE OPERATORS (ALTERNATE 8)

A. Gate operators must conform to UL325, Standards for Safety. The operator must be tested by an independent testing laboratory such as UL or ETL and found to conform to these standards. The completed installation shall conform to applicable ASTM and UL requirements.

B. Basis of Design Units: HySecurity Slide Driver Unit, sized to opening and weight of gates.
1. Subject to compliance requirements, alternate approved manufacturer(s) include:
a. DoorKing

C. All electrical work is to be done by qualified electricians and is to conform to all applicable local, state, and federal codes.

D. General Operation
1. The operator must be designed for high-cycle applications and low maintenance. The operator shall be capable of actuating gates up to 30 feet in overall length. The gate operator must be able to operate gates up to 150 per cent of weight of actual gate at 1.7 feet per second.
2. All fasteners, except structural bolts, are to be stainless steel, or other non-corrosive material.
3. The operator is to provide wear compensating, spring-loaded, friction-feed type drive mechanism. The drive mechanism is to consist of two drive wheels that can be manually disconnected by a toggle style disconnect. This disconnect is to instantly disengage the drive wheels for manual operation. The operator, upon returning to automatic operation by engaging the drive mechanism, shall function properly without regard to the gate’s actual position.
4. Operators shall be provided with the following options:
a. UPS backup: DC battery backup for full functionality during periods of AC power loss.

E. Housing Construction
1. The housing cover must swing open to allow access to the internal components.
2. The housing cover must be lockable.
3. All operator cover locks are to be keyed alike.
4. The housing, chassis and cover to be galvanized for corrosion resistance per ASTM 123 M.

F. Electric Motor
1. The electric motor used in the gate operators must have a continuous-duty rating of two horsepower with a service factor of 1.15 or greater and shall be available in all voltages and phases to suit the installation requirements of the site.
2. The electric motors must have built-in overload protection and resettable with a sealed pushbutton reset.

G. Hydraulic System
1. The hydraulic system must be self-contained and contain pump, reservoir, two position control valve, hydraulic hoses, fittings and hydraulic motors.

2. All hydraulic hoses shall have a minimum burst pressure of 12,000 pounds per square inches.
3. The hydraulic motors must be automatically locked when the control valve is in the de-energized to prevent slippage of the drive wheels.
4. The hydraulic system must be soft-start and soft-stop to minimize shock loads transmitted to the gate system including a reverse delay to maximize gate hardware life.

H. Electrical
1. Built in "warn before operate" system.
2. 26 programmable user relay output options.
3. Built-in power surge / lightning strike protection.
4. Control circuit: 24VDC.
5. Electrical enclosure: Oversized, metal, with hinged lid gasketed for protection from intrusion of foreign objects, and providing ample space for the addition of accessories.
6. Menu configuration, event logging and system diagnostics easily accessible with integral touchpad or a PC and free START software.
7. Limit switch shall feature a built in LED "tripped" indicator light. The limit switch must readily accessible, adjustable and replaceable with normal hand tools.
8. The limit switches are to provide the ability to remote monitor the gate position when in the fully closed and fully open positions.

I. Accessories
1. Through beam type photo detectors, and contact sensor at leading edge of gate.
2. Strobe or other similar visual beacon to operate simultaneously with standard gate operator "warn before operate" audible beacon.
3. Fire Department Operation: Provide with fire department lock box.
   a. Mounting: Provide and mount on free standing stanchion.
4. Card Reader and Accessories: Programmable placement card readers for exterior applications with canopy light, on heavy duty goose neck post set in concrete footing. Card readers and accessories shall be provided by Owner's access control vendor. Provide back-boxes, conduits, and pull string to goose-neck post as required by Owner's vendor for required card readers and any additional accessories.
5. Signage: Provide motorized gate safety advisory signage compliant with code requirements, with attachment hardware as required, to mount at each side of motorized gates.

J. Inductive vehicle loop detectors
1. Inside and outside obstruction loops are to be installed to prevent the gate from closing when vehicle traffic is present.
2. Free exit loops are to be installed for exit lane gates.
3. Loops for gates with heavy truck traffic will have no side of the loop less than 6'.
4. Loop wire to be stranded Thhn or XLPE, crosslink poly-ethelene jacketed type acceptable for direct burial.
5. Refer to detail drawings for specific loop placement or refer to manufacturers recommendations.

2.08 SETTING MATERIAL

A. Concrete: Minimum 28 day compressive strength of 3000 psi (20 MPa).

B. Flanged Posts: Provide flange type base plates with 4 holes for surface mounting of posts where indicated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify grading adjacent to fence locations, and other requirements for installation, are complete. Coordinate power location and requirements for gate hardware with electrical contractor. Coordinate requirements for gate hardware installed by other trades with hardware installer.

B. Lay out fence according to construction Drawings.

C. Gate Operator: Coordinate conduit runs and electrical connections with the work of Electrical and Access Control work by other trades, including with access control by separate contract where applicable.

3.02 FENCE AND GATE INSTALLATION

A. General: Install per Manufacturer's installation instructions. Attach hardware by means which will prevent unauthorized removal. Install gates plumb, level and secure for full opening without interference. Adjust hardware for smooth operation.

B. Concrete Set Posts: Drill hole in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than nominal outside dimension of post, and depths approximately 6" deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed soil, or greater where recommended by fencing Manufacturer for post height. Place concrete around post in a continuous pour. Trowel finish around posts and slope to direct water away from posts on all sides

1. Gate Posts and Hardware: Set gate keepers into minimum 9" diameter x 18" deep concrete footings. Set stops, sleeves and other accessories into concrete paving or footings as applicable.

C. Surface mount (wall mount) posts with mounting plates where indicated. Fasten with lag bolts and shields.

D. Check each post for vertical and top alignment, and maintain in position during placement and finishing operation.

E. Fence panels shall be attached to posts according to manufacturer's installation instructions.

F. Where fence materials must be cut in field, and where minor damage to finish can be repaired to Architect's satisfaction, touch up and seal paint finishes per manufacturer's instructions using manufacturer's recommended repair paint and sealer materials.

G. Install gates per approved shop drawings and manufacturer's instructions. Install with all hardware as per approved shop drawings and as called for in the construction Drawings. Verify that gate is operating smoothly and without obstructions under manual conditions prior to installation of gate hardware. Do not proceed with hardware installation until gate is aligned and operates without binding.

1. Install motorized gates and adjacent fencing to comply with reference standards and as described in Part 1 of these specifications. Install safety advisory signage at each side of motorized gates in locations that are readily visible.

3.03 FIELD QUALITY CONTROL FOR GATE OPERATORS

A. Test gate operator through at least ten full cycles and adjust for operation without binding, scraping or uneven motion.

B. Test all safety devices and detectors for proper operation. Test limit switches for proper "at rest" gate position. Test all controls for proper operation, including key switch operation controls, where applicable.
   1. Test operation of access controls system installed by other trade, jointly with access controls installer, as required to resolve any faulty operation.

C. All anchor bolts shall be fully concealed in the finished installation.

D. Coordinate, schedule and provide gate operator Manufacturer's site observations and complete Manufacturer's punch list items prior to final acceptance of the installation and submission of completed warranty documentation, as applicable to Manufacturer's warranty requirements.

3.04 CLEANING AND ADJUSTING

A. Verify all operable parts are properly lubricated and functioning. Check all mechanical connections for tightness and alignment.

B. Prior to substantial completion, clean the fence as recommended by manufacturer.

C. Remove post-hole excavation material, or if material is not detrimental to landscaping then scatter uniformly to grade prior to landscaping installation.

D. Remove excess jobsite materials.

3.05 DEMONSTRATION AND TRAINING

A. Demonstrate operation and train Owner's personnel in operation and maintenance of motorized gate systems to comply with Division 01 "Demonstration and Training".

END OF SECTION 32 31 19

SECTION 32 84 00 - PLANTING IRRIGATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Piping.
   2. Encasement for piping.
   3. Manual valves.
   4. Pressure-reducing valves.
   5. Automatic control valves.
   6. Automatic drain valves.
   7. Transition fittings.
   8. Dielectric fittings.
   9. Miscellaneous piping specialties.
   10. Sprinklers.
   11. Quick couplers.
   12. Drip irrigation specialties.
   13. Controllers.
   14. Boxes for automatic control valves.

1.03 DEFINITIONS

A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

E. Irrigation Mains: That portion of piping from water source to remote control valves. This portion of piping is subject to surges, being a closed portion of

irrigation system. Hydrant lines (QCV) are considered part of main line piping system.

F. Lateral Piping: That portion of piping from remote control valve to sprinkler heads.

1.04 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
   1. Irrigation Main Piping: 260 psi.
   2. Circuit Piping: 150 psi.

1.05 DESCRIPTION OF WORK

A. Areas receiving underground sprinkler system is shown on drawings.

B. Design shall be completed by licensed Irrigation Designer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide underground sprinkler system as a complete unit produced by a single acceptable manufacturer, including heads, valves, piping circuits, controls, and accessories.

1.07 REFERENCES

A. ASTM - American Society for Testing Materials
   1. D2241: Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR).
   2. D2287: Flexible Polyvinyl Chloride (PVC).
   3. D2464: Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Threaded, Schedule 80.
   4. D2466: Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Socket Type, Schedule 40.
   5. D2564: Solvent Cement for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.
   6. D2855: Making Solvent - Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.

1.08 SYSTEM DESCRIPTION

A. Design requirements:
   1. Coverage indicated on Drawings and specified herein. Layout portions of irrigation system not indicated on Drawings to meet specified coverage in compliance with local codes and regulations.
   2. Complete irrigation system including trenching and back filling for all pipes, values and drain pits, providing mains, laterals, risers, fittings, sprinkler heads, values, controllers, electric wiring, and necessary specialties and accessories.
   3. Sleeves beneath parking areas, walkways, roads, and driveways where required.
   4. Regulate and adjust sprinkler heads, timed sequence control devices, sectional valves and rain overrider.
   5. Each zone to be comprised of approximately equal water demand. Pressure not to exceed 6 feet per second.
   6. Sprinkler heads in a zone shall have the same precipitation rate.
   7. Provide 100 percent coverage by locating heads as recommended by the manufacturer. Proper overlap shall prevent “scalloping”. No throw is permitted over walks, drives or buildings.
   8. Turf and unlike plant materials shall be zoned separately based on water needs.
   9. Locate heads discretely using risers only in shrub beds.
   10. Heads adjacent to pavement shall be installed on swing joints.
   11. Consider all plant heights and grade changes in design and installation of the irrigation system.

1.09 SUBMITTALS

A. Division 01: Section - Submittal Procedures

B. Product Data: Manufacturer's product data with installation and storage instructions for each product specified.
   1. Shop Drawings:
      a. Indicate location of irrigation heads to match specified water coverage. Indicate valves, piping and accessories, show design pressure, valve size, pipe size, GMP requirements, drain valves, and sleeves.
      b. Show location and size of city/county main, size of tap to be made, water meter location, and backflow prevention size and location.

C. Division 1: Section – Closeout Procedures
   1. Operating and Maintenance Instructions: Provide two copies of instructions for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer’s parts catalog.
      a. Include winterization procedures.
      b. Indicate length of time each valve is to be open to produce a given amount of water delivery.

   2. Record drawings:

a. Indicate locations, sizes and kinds of equipment installed.
b. Dimension from 2 permanent points of reference (building corners, sidewalk, or road intersections, etc.) the location of the following items:
    1) Connection to water lines.
    2) Connection to electrical power.
    3) Gate valves.
    4) Routing of sprinkler pressure lines (dimension max. 100' along routing).
    5) Significant changes in routing of lateral lines form those indicated on Drawings.
    6) Sprinkler control valve.
    7) Routing of control wiring.
    8) Yard hydrants and quick coupling valves.

3. Controller Charts:
    a. Record Drawings shall be approved by the Contracting Officer before controller charts are prepared.
    b. Submit 2 controller charts for each controller.
    c. Show the area controlled by the automatic controller. It shall be the maximum size which the controller enclosure door will allow.
    d. The chart shall be a reduced drawing of the actual as-built system If controller sequence is not legible when the drawing is reduced, enlarge to size that will be readable when reduced.
    e. Chart shall be a blackline or blueline ozalid print. Use a different color to indicate the area of coverage for each station.
    f. When approved, hermetically seal chart between 2 pieces of plastic and securely mount to controller enclosure door.

1.10 PROJECT / SITE CONDITIONS

A. Existing Utilities: Be responsible for locating and identifying existing utilities. Notify Architect of any conflicts which affect the approved irrigation layout.

B. Obstructions Below Grade: If obstructions such as rock or underground construction work are encountered in any irrigation excavation work, alternate locations will be selected. Where locations cannot be changed, removed obstruction. The obstruction shall be removed to a depth of not less than 3 feet below grade.

C. Damage by Leaks: Be responsible for damage to the grounds, plants, walks, roads, building piping system, electrical systems, and their equipment and contents cause by leaks in piping systems being installed or having been installed. Repair damages so caused at no additional cost to the Owner.

D. Staking: Be responsible for location staking. Irrigation head locations shall be determined by calculating dimensions from approved shop drawings. Adjustments may be necessary to avoid interference with underground obstructions.

1.11 WARRANTY

A. Repair any settling of backfilled trenches which may occur during the warranty period.

B. Restore all damaged plantings, paving, or improvement within the warranty period.

C. Materials and equipment shall be warranted in writing against defects in materials and workmanship by the respective manufacturers. All installation work shall be guaranteed for two years after final acceptance.

D. No claims under warranty shall be considered for materials damaged or destroyed by vandals or damages caused by unauthorized operations of the system.

1.12 MAINTENANCE TOOLS

A. Provide 2 sets of tools for removing, disassembling and adjusting each type of sprinkler head and valve supplied.

B. Provide three quick coupling keys and three ¾ inch hose swivels as part of this contract.

C. Provide 2 five foot keys for operation of gate valves.

D. Provide 2 keys for each automatic controller.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Heads, valves, controllers, backflow preventers, yard hydrants and other components as scheduled on shop drawings.

B. Pressure Mainlines and Non-Pressure Lateral Lines: All pipe, in sizes indicated on the shop drawings shall be marked continuously and permanently with the following information: Manufacturer's name, nominal pipe size, class or schedule, and NSF approval, and type of pipe.

2.02 PIPE AND PIPE FITTINGS

A. Irrigation Mains:
   1. Pipe: ASTM D 1784, PVC Schedule 40, SDR-21, 260 psi maximum.
   2. Joint: ASTM D 2241 bell end type
   3. Fittings: Schedule 40, ASTM D 2466 solvent cement type.

B. Zone Lateral Lines:

1. Pipe: ASTM D 1784, PVC Class-200, SDR-21.
2. Joints: ASTM D 2241 bell end.
3. Fittings: ASTM D2 466 Socket type.

C. Gate Valves:
1. 3" and larger: Iron body, non-rising stem, threaded ends.
2. 2-1/2" and smaller: Type 1, class 150 psi, threaded ends.

D. Station Control Valves:
1. Station Control Valves: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following.
   a. "PGV Series" – Hunter Industries, San Marcos, CA 760-744-5240.
2. Valve Type: Remote control valves.
3. Primers and Solvents: As recommended by PVC pipe manufacturer.

2.03 SPRINKLER HEADS

A. Small Area Heads (for use in small lawn/shrub areas):
1. Small Area Heads: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following:
   a. "PCB Bubbler" – Hunter Industries, San Marcos, CA 760-744-5240.
   b. "Pro-Spray" series – Hunter Industries, San Marcos, CA 760-744-5240.
2. Each head shall have an interchangeable nozzle (available in different patterns and distances of throw).
3. Each head shall have a basket screen.
4. Provide pressure compensating screens (P.C.S) as indicated on Drawings.

B. Large Area Heads (for use in large lawn areas)
1. Large Area Heads: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following.
   a. "PGP-ADJ/Ultra" Series – Hunter Industries, San Marcos, CA 760-744-5240.
2. Use adjustable arc (ADJ) unless Drawings show full circle (360)
3. If water pressure is excessively high, provide pressure reducing feature on zone valves.

2.04 AUTOMATIC CONTROL SYSTEM

A. Automatic Controllers: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following.
1. Manufacturer: ACC-99D – Hunter Industries, San Marcos, CA 760-744-5240.
   a. Primary Surge Protector
   b. ICD-XXX Decoders as Required for future expansion of system.

c. (Lock) Provide Owner with two keys.

B. Division 1: Section – Product Requirements.

C. Substitutions: Permitted.

D. Stations: Control stations as shown on shop drawings.

E. Station Timing: Independent for each station with each infinitely adjustable from 0 to 60 minutes.

F. Day Programming: Programming dials encompassing 14-day cycle.

G. Operation: Capable of automatic or manual function as selected by operator.

H. Power Requirements:
1. Input: 115 volt AC
2. Output to Valves: 24 Volts AC.

I. Provide reset circuit breaker for overcurrent protection.

J. Provide master manual on-off switch.

K. Rain Detector:
1. Rain Detector: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following.
   a. "Mini-Clik" by Glen-Hilton Products, Inc., Bethesda, MD, (301) 441-8673.
   b. As recommended by Controller manufacturer
2. Division 1: Section – Product Requirements.
3. Follow manufacturer's recommendations for mounting and confirm location with Owner and Architect.

2.05 VALVE BOX

A. Valve Boxes: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following.
1. Ametek, Plymouth Products Division, Sheboygan, WI (414) 457-9435, Superflexon Valve Box "No.10-170-001" with cover No. "10-173-004", with pentagon (1) locking device.

B. Division 01: Section – Product Requirements. Substitutions permitted.

C. Paint box covers matte black with paint specified in Section 099000 – Painting.

2.06 SWING JOINTS

A. Swing joints are to be made of Schedule 40 pipe with insert to male thread combination elbows. The swing joint will allow for precise adjustments of each head to grade as well as protecting both the head and the pipe from damage if struck by unusual force.

2.07 CONTROL WIRE

A. Control Wire: All wire shall be #14 AWG solid copper, single conductor, rated U.F. with U.L listing, with 600 volt PVC insulation. All splices shall be made with wire nuts and totally encased in DBY direct burial splice kits.

2.08 QUICK COUPLING VALVES

A. Quick Coupling Valves: Subject to compliance with requirements, manufacturers offering specified items which may be incorporated in the work include the following:
   1. Hunter "HQ" Series.

B. Mount quick coupling valves on ¾ inch galvanized triple swing joints. All swing joints are to be assembled using two to three wraps of Teflon tape.

2.09 DRIP IRRIGATION

A. NOT ALLOWED. Use bubblers/small area spray heads in place of drip lines for irrigation in planting beds.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Division 1: Section – Execution Requirements

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

C. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 PREPARATION

A. Coordinate work which is embedded in concrete or masonry and route under paved areas.

B. Provide timely delivery and installation at job site.

C. Protect adjacent structures, surfaces, and finishes. Do not move equipment over structures without written approval from Architect. Provide necessary protection such as board roading, drop cloths, etc., as required.

3.03 INSTALLATION

A. Sequencing:
   1. Install sleeves under roads and pavement prior to commencement of paving.
   2. Install sprinkler system after completion of site grading.

B. Minimum Cover Below Finished Grade:
   1. Zone Lateral Pipe: Not less than 12 inches.
   2. Mains: Not less than 24 inches.

C. Clearance Horizontally Between Lines:
   1. Pipe 2 inches and smaller: 4 inches.
   2. Pipe 2-1/2 inches and larger: 12 inches.
   3. Other services: 12 inches.

D. Maintain a minimum 1 inch vertical clearance between lines crossing at an angle greater than 45 degrees.

E. Trench Width: Not less than 6 inches.

F. Install underground piping so that it is not in contact with concrete, existing piping or other hard objects. Provide a minimum clearance of 2 inches between piping and hard object.

G. Thrust blocks: Concrete thrust blocks shall be provided on the thrust side of mains.

H. Backfill: Division 1: Section – Earthwork
   1. Material shall not contain brick, rock lumber or organic materials subject to decomposing.
   2. Trenches, after backfilling, shall be water filled and settled to prevent aftersettling.
   3. Level with finished grade.
   4. After backfilling and water settling, soil around pop-up heads shall be tamped and heads left level with grade and plumb.

I. Piping Installation:
   1. Install plastic pipe in a manner to provide for expansion and contraction.
   2. Cut plastic pipe with a hand saw. Ensure a square cut. Remove burrs at cut ends prior to installation.

3. Plastic to plastic joints shall be solvent-welded. Solvent compatible with pipe and able to withstand specified pressure requirements.
4. Solvent Welded Joints:
    a. Thoroughly clean pipe and fitting with all purpose primer/cleaner and clean dry cloth.
    b. Apply a uniform coat of solvent to the outside of the pipe.
    c. Apply solvent to the fitting.
    d. Re-apply a light coat of solvent to the pipe and quickly insert into the fitting.
    e. Re-apply a light coat of solvent to the pipe and quickly insert into the fitting.
    f. Give the pipe or fitting a quarter turn to ensure even distribution of the solvent and make sure the pipe is inserted to the full depth of the fitting socket.
    g. Hold in position for 15 seconds.
    h. Allow joints to set at least 24 hours before pressure is applied to the system

J. Valves:
1. Manual Valves: Install manual valves in a valve box extending from grade to valve body, with minimum of 4 inch cover measured from grade to top of valve stem.
2. Automatic Valves:
    a. Install automatic valves plumb to within 1/16 inch, in a valve box extending from grad to valve body, with minimum of 4 inch cover measure from grad to top of valve stem.
    b. Automatic valves installed under sprinkler heads may be installed without valve box,
    c. Automatic drains valves: Locate downstream of each control valve at the low point.

K. Sprinklers and Quick Coupler:
1. Install plumb to within 1/16 inch.
2. Heads at Walks and Curbs: Set flush to within 1/8 inch.
3. Lower sprinkler heads to finished grade after lawn has become established and has settled.

L. Control Wire:
1. Bury wires taped to side of pipe in same trench.
2. Bundle multiple wires and tape together maximum 10 feet on center.
3. Provide a 10 inch loop in wire at each valve where controls are connected.
4. Provide 10 inch loop in wires at not over 100 foot intervals.
5. Make electrical splices waterproof.

3.04 CONSTRUCTION

A. Interface with Other work:
1. Locate and coordinate irrigated system work with underground utilities.

2. Coordinate irrigation system work with landscaping work.
3. Coordinate irrigation system sleeve installation with curbing and pavement work.

3.05 FIELD QUALITY CONTROL

A. Division 01: Section – Quality Control

B. Inspection:
   1. Trenching.
   2. Pressure supply line installation and testing.
   3. Lateral line and electrical valves.
   4. Coverage tests.

C. Testing and Flushing
   1. Flushing:
      a. After all piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, yard hydrant assemblies, and hose valves, thoroughly flush piping system under a full head of water.
      b. Maintain flushing for 3 minutes through furthermost valve.
      c. After flushing, cap all risers.
   2. Adjusting:
      a. Flush and adjust all sprinkler heads for optimum performance and to prevent over-spray onto walks, roadways, and building.
      b. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, make such adjustments prior to planting. Adjustments may include changes in nozzle size and degrees of arc as required.
      c. Lower raised sprinkler heads within 10 days after notification by Architect.
      d. Sprinkler heads shall be performed at no cost to Owner.
   3. Testing:
      a. Test all pressure lines under hydrostatic pressure of 150 pounds per square inch. Prove water tightness.
      b. Testing of pressure main lines shall occur prior to installation of electric control valves.
      c. Sustain pressure in lines for not less than 2 hours. If leaks develop, replace joints and repeat test until entire system has been accepted.
      d. Furnish force pump and accessory test equipment.
      e. When the irrigation system is completed, perform a coverage test in the presence of the Owner or Owner's representative to determine if the water coverage for planting areas is complete and adequate. Correct inadequacies of coverage due to deviations from Drawings. Complete test before ground cover is planted.

3.06 SYSTEM OPERATION AND ACCEPTANCE

A. Operation:
   1. Operate the completed system for the inspection at this time each sprinkler head shall be visually checked for coverage, adjustment, installation and performance; valves shall be inspected for adjustment, installation and proper automatic manual control; “record documents” will be checked for accuracy; cleanup of site will be checked; and general items such as manual drain valves, controller and quick couple valves will be inspected for the maintenance period.

B. Instruction:
   1. Instruct Owner in complete operation and maintenance of the irrigation system including but not limited to the controller operation, maintenance of the system’s filters, adjustment of heads and winterization of system.

END OF SECTION 32 84 00

SECTION 32 92 19 - SEEDING

PART 1 GENERAL

1.01 SUMMARY

A. This specification describes the requirements for the seeding, application of fertilizer, and other management practices to establish ground cover in all areas disturbed by construction, or as otherwise shown on the Drawings and as designated in the specifications.

1.02 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.03 QUALITY ASSURANCE

A. A tag with written certification of guaranteed product content shall be attached to the product bags or containers, or a separate written certification of guaranteed product content shall be provided by the product supplier or manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be transported, stored, and handled according to the written recommendation of the manufacturer or supplier.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Seed. The seed shall be common Bermuda grass (hulled) and ryegrass. All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing purity, germination, name and type of seed. Seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within nine (9) months of the time of delivery to the project. Each variety of seed shall be furnished and delivered in separate bags or containers.

B. Fertilizer. The fertilizer shall be standard pelleted or granulated commercial fertilizer supplied separately or in mixture containing the percentages of total nitrogen, available phosphoric acid, and water soluble potash of 12-12-12.

2.02 SOURCE QUALITY CONTROL

A. When requested by Engineer, submit samples of seed and fertilizer for analysis and testing prior to planting.

PART 3 - EXECUTION

3.01 PREPARATION

A. Planting Season. The ryegrass shall be planted between September 1 and May 1. Bermuda grass shall be planted between March 1 and October 1. When planting seasons overlap, plant both Ryegrass and Bermuda.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Application Rate:
   1. Seed for areas outside of TxDOT right-of-way:
      a. Bermuda Grass: Not less than five (5) pounds pure live seed per acre.
      b. Ryegrass: Not less than thirty (30) pounds pure live seed per acre.
   2. Seed for areas within TxDOT right-of-way: Seeding in TxDOT right-of-way shall be in accordance with Item 164 of the latest version of TxDOT's Standard Specifications for Construction of Highways, Streets, and Bridges.
   3. Fertilizer: Not less than three hundred (300) pounds per acre.

B. Broadcast Seeding: The seed or seed mixture in the quantity specified shall be uniformly distributed over the areas to be seeded. If the sowing of seed is by hand, rather than by mechanical methods, the seed shall be sown in two directions at right angles to each other. If mechanical equipment is used, all varieties of seed as well as fertilizer may be distributed at the same time provided that each component is uniformly applied at the specified rate. After planting, the planted area shall be rolled with a corrugated roller of the "Cultipacker" type. All rolling of slope areas shall be on the contour.

3.03 REPAIR/RESTORATION

A. Any areas damaged by erosion or that do not achieve an acceptable coverage shall be replanted.

3.04 FIELD QUALITY CONTROL

A. Work under this section shall achieve a ground cover of at least 70% that has been growing for at least 60 days throughout the area to be seeded as determined by the percent of area covered in any selected square yard of seeded area.

END OF SECTION 32 92 19

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Standard Form of Construction Agreement, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Plants.
   2. Soil Preparation Materials.
   3. Miscellaneous Materials.
   4. Tree Planting.

B. Related Sections include the following:
   1. Division 32 Section "Irrigation System"

1.03 DESCRIPTION

A. Provide complete landscaping shown on Drawings.

1.04 QUALITY ASSURANCE

A. Provide plant materials in compliance with applicable State and Federal laws relating to inspection for diseases and insect infestation at growing site.

B. Observation at growing site does not preclude right of rejection at job site. Plants damaged in transit or at job site may be rejected.

C. Off-site sandy loam testing (paid by Landscape Contractor):
   1. Provide source of sandy loam soil to Architect for purpose of soil investigation.
   2. Test soil samples from both sources of pH, alkalinity, total soluble salts, porosity, sodium content, and organic matter.

1.05 REFERENCED STANDARDS

A. American Standard for Nursery Stock, approved October 27, 1980 by American National Standards Institute, Inc.

B. Hortus Third, 1976 - Cornell University

1.06 SUBMITTALS

A. Division 01: Section - Submittal Procedures

B. Samples: Submit for approval sufficient representative quantities of sandy loam, sharp sand, bark chips, peat moss, filter fabric and gravel. Samples shall be approved by Architect before use on project.

C. Submit three representative samples of each of the specified ornamental trees, shrubs, and ground cover plants for Architect's approval. When approved, tag, install and maintain as representative samples for final installed plant materials.

D. File Certificates of Inspection of plant material by State and Federal authorities with Architect, if required by State.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Preparation for Delivery:
   1. Balled and Burlapped (B&B) Plants: Dig and prepare shipment in a manner that will not damage roots, branches, shape, and future development.
   2. Container Grown Plants: Container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

B. Delivery:
   1. Packaged materials delivered in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.
   2. Do not deliver more plant materials than can be planted in one day unless adequate storage and watering facilities are available on job site.
   3. If balled plants cannot be planted within 24 hours after delivery to site, protect root balls by heeling in with saw dust or other approved material.
   4. Protect during delivery to prevent damage to root ball or desiccation of leaves.
   5. Notify Architect of delivery schedule 48 hours in advance so plant material may be observed upon arrival at job site.
   6. Remove rejected plant material immediately from site.
   7. Do not lift, move, adjust to plumb, or otherwise manipulate plants by trunk or stems.

1.08 JOB CONDITIONS

A. Planting Restrictions: Perform actual planting only when weather and soil conditions are suitable in accordance with locally accepted practice.

B. Protections:
   1. Do not move any equipment over existing or newly placed structures without approval of Architect and General Contractor. Provide necessary protections such as board-roading as required.
   2. Protect other improvements from damage, with protection boards, ramps and protective sheeting as required.

C. Utilities:
   1. Determine locations of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, if required, to minimize possibility of damage to underground utilities. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

1.09 WARRANTY

A. Warranty plants and trees for one year after substantial completion. Following Warranty Period Inspection, replace dead materials and materials not in vigorous, thriving condition as soon as weather permits and on notification by Architect. Replace plants, including trees, which in the opinion of the Architect, have partially died, thereby damaging shape, size or symmetry.

B. Contractor shall replace plants and trees with same kind and size as originally planted and dispose of dead material at no cost to Owner. Provide one-year guarantee on replacement plants. Trees should be replaced at start of next planting or digging season. In such cases, remove dead trees immediately. Protect irrigation system and other piping conduit or other work during replacement. Repair any damage immediately.

C. Guarantee excludes replacement of plants because of injury by storm, freeze or neglect by Owner.

D. Provide explicit maintenance and care instructions of all plant material.

PART 2 - PRODUCTS

2.01 PLANTS

A. General: Plants shall be equal to well-formed No. 1 grade or better nursery stock in accordance with requirements of applicable standards and as noted herein subject to Architect's approval. Listed plant heights are from tops of root balls to nominal tops of plants.

B. Ground Covers: Nursery grown, healthy, vigorous, of normal habit of growth for species, free from disease, insect eggs and larvae.

C. Ornamental Trees and Shade Trees: Healthy, vigorous, full-branched, well-shaped, trunk diameter and height requirements as specified. Balls shall be firm, neat, slightly tapered and well burlapped. Trees with loose or broken balls at time of planting shall be rejected. Trees will be individually approved by Architect, and must comply with City of Georgetown approved plants list.

D. Hydro-mulch
   1. Grass: Bermuda Seed: Shall be extra hulled and treated lawn type seed, delivered to the site in its original unopened container, and shall meet Texas State Law requirements.
   2. Fiber: Shall be one hundred (100%) percent Wood Cellulose Fiber, delivered to the site in its original unopened container, Conweb or equal.
   3. Fiber Tack: Shall be delivered to the site in its original unopened container, and shall be Terra-Tack One, as manufactured by Grass Growers, Inc., or equal.

E. Grass Sod : ASPA Nursery growth cultivated Bermuda sod with strong fibrous root system, free of stones, burned spots and minimal weeds.

2.02 SOIL PREPARATION MATERIALS

A. Sandy Loam:
   1. Friable, fertile, dark, loamy soil, free of clay lumps, subsoil, stones, and other extraneous material. Reasonably free of weeds and foreign grasses. Soil containing Dallis grass or Nutgrass shall be rejected.
   2. Physical properties as follows:
      Clay - between 7-27 percent Silt - between 28-50 percent Sand - less than 52 percent

B. Sharp Sand: Clean, washed sand, fine to coarse sizes.

C. Decomposed Pine Bark Mulch: Obtained from disease-free wood, 100 percent of which is 9 in² or less in area, and 50 percent is more than 1 in² in area. The mulch should contain no noxious weed seeds, soil, sawdust or any substance toxic to plant growth and be at least two years old.

D. Commercial Fertilizer: Commercial fertilizer shall be a complete fertilizer with an organic base. It shall be uniform in composition, dry, and free-flowing. Fertilizer shall be delivered to the site in the original unopened containers, each bearing the manufacturer's guaranteed statements of analysis, and shall meet the following requirements, or equal, for approval.

2.03 MISCELLANEOUS MATERIALS

A. Steel Edging: 1/8" x 4" “TouhEdge" by Coyote Landscape Products. Color Black.
   1. Accessories: Corner pieces where 90 degree corners are required.

B. Perforated Steel Edging: 16 gauge by 4” tall “Perfedge” by Coyote Landscape Products. Color Black.

C. Wrapping Material: Waterproofed, asphalt based paint with antiseptic properties, manufactured for use on tree wounds.

D. Tree Paint: Waterproofed, asphalt based paint with antiseptic properties, manufactured for use on tree wounds.

E. Mulch: Cypress bark decorative mulch rated 2 inch to 3 inches. Color to be selected by Architect.

F. Pea Gravel: Washed 3/4 inch native pea gravel.

G. River Rock: Washed 1” – 3” native river rock.

H. Landscape Boulders: native Limestone, size range as indicated on drawings.

I. Guying Materials:
   1. Tie Wire: 12 gauge galvanized wire.
   2. Black Hose: 2 ply, fiber reinforced hose, minimum 1/2 inch inside diameter.
   3. Eye Bolts: Galvanized steel, 3/8 inch eye, 6 inches long.
   4. Turnbuckles: Galvanized steel, 3/8 inch eye, 6 inch opening.
   5. Steel T Posts: 48 inch length.
   6. Colored flag attached to tie wire

J. Transite Edging: 3/8 Inch thick by 24 inches deep by 42 inches long corrugated transite edging.

K. Weed Stopper: "Processional Landscape Fabric", 3 oz Spunbond by Fabriscape, Chicago, IL

L. Erosion Control Netting: “Fabrijute”, Photo/Bio-degradable netting by Fabriscape, Chicago, IL

M. Perforated PVC pipe 4”

N. Perforated PVC pipe with cap 3”

O. Corrugated Perforated HPDE pipe 4”, black.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine subgrade upon which work is to be performed, verify grade elevations, that bed areas are left four inches low, observe conditions under which work is to be performed, and notify General Contractor of unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor. Notify Architect before proceeding.

3.02 BED PREPARATION

A. Provide additional four inches of excavation for shrub beds and backfill eight inches deep; four inches deep for ground cover.

1 part sandy loam
1 part peat moss
1 part sharp sand
Add four pounds commercial fertilizer, as determined by testing, per 100 SF of bed area and mix thoroughly.

3.03 GRASS AREAS

A. Lawn areas as indicated on plan, or existing lawn areas disturbed by construction activity shall be hydro-mulched. Hydro-mulch with Bermuda at the rate of two pounds per 1,000 SF. Fertilizer component of hydro-mulch shall be 20 pounds per 1,000 SF (16-20-0 Fertilizer). Mulch component of hydro-mulch shall be wood cellulose fiber at the rate of 50 pounds for 1,000 square feet.

1. If hydro-mulch is to be planted during winter months, inform the Architect and coordinate potential alternate grass type.

B. Areas to receive sod as indicated on plan shall be laid on prepared moistened surface within 48 hours of harvesting and immediately upon delivery to site. Lay sod tight with no open joints visible, and no stretching or overlapping: stagger end joints by 12" minimum. Lay smooth with top elevation ½" below adjoining paving. Water immediately after installation.

3.04 SPACING

A. Place plants in position on bed areas before containers have been removed. Obtain approval from Architect. Do not remove burlap from BB plants. Plant where located, setting plants with tops of balls even with tops of beds, and compact soil carefully around each plant ball. Water each plant thoroughly with hoses to eliminate air pockets. Carefully prune plants to remove dead or broken branches and hand-rake bed areas to smooth even surfaces. Architect reserves right to interchange or shift locations of plants prior to planting.

3.05 TREE PLANTING

A. Ornamental Trees: Plant trees in pits larger than tree ball, as recommended by local nursery, but no less than 12" larger. Backfill with prepared soil as defined above.

B. Shade Trees:
   1. Plant in tree pits greater in diameter than root balls, as recommended by local nursery, but no less than 2' – 0" larger, or to edge of tree leave-outs in paved areas. Remove excavated soil from site.
   2. Coordinate with electrical contractor in cases where tree uplights are to be installed.
   3. For those trees indicated on plans, slope bottom of tree well excavation to drain to sump. Install six inches of pea gravel in bottom of tree well. Provide single layer of filter fabric over gravel. Center tree in well.
   4. Backfill pits with five parts sandy loam to one part peat moss and carefully settle by watering to prevent air pockets.

3.06 TREE GUYING

A. Complete guying as detailed immediately after trees are planted.

3.07 MULCHING

A. After planting has been completed and approved by Architect, mulch bed areas with bark mulch, two inches deep.

3.08 EDGING

A. Install metal edging to separate grass areas from ground cover and bed areas.

B. Install perforated metal edging where planting or river rock beds abut directly to building edge to allow excess water to drain away from building.

3.09 TREE WRAPPING

A. Wrap nursery grown trees. Extend wrapping from ground to a point immediately below lowest branch of each tree or as directed. Securely fasten in place with tacks or staples, so wrapping will remain in place two years.

3.10 PRUNING OF NEW PLANT MATERIAL

A. Trees are to be pruned to preserve natural character of plant and in a manner appropriate to its particular requirements in landscape design as determined by Architect. In

general, remove at least one-third of wood by thinning branches. Do not cut leaders. Pruning in general shall be heavier on collected than on nursery grown plants. Remove soft wood or sucker growth and broken or badly bruised branches with a clean cut.

3.11 MAINTENANCE BY CONTRACTOR

A. The Contractor is responsible for maintenance of all trees, shrubs, ground cover and turf, including all necessary watering, cultivating, weeding and spraying until substantial completion of the entire project. Plant materials shall be kept in a healthy and vigorous condition with all bed areas kept neat.

B. Water will be available on site at no expense to the Contractor. Hose and other watering equipment required for maintenance by Contractor shall be furnished by Contractor at his expense. Additional water will be available as sprinkler system becomes operational, but this in no way relieves the Contractor of maintenance of plant material until acceptance by the Owner.

C. Grass areas shall be mowed at regular intervals to maintain a maximum height of two inches. Do not cut more than 1/3 of grass blade at any one mowing. Remove clippings after mowing.

END OF SECTION 32 93 00

SECTION 33 06 00 - UTILITY SERVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Furnish all labor, materials, services, equipment and appliances required in conjunction with or properly incidental to the furnishing and installation of site drainage system complete as indicated on the Drawings and as specified herein, including:
      a. Layout of drainage and utility lines
      b. Excavation for trenching, de-watering and backfilling
      c. Reinforced concrete drainage structures and related covers, grates and frames
      d. Connection of drainage piping to existing drainage line
      e. Lateral drainage lines to locations indicated on Drawings for connection to roof drainage piping
      f. Water distribution system
      g. Sanitary sewer system
      h. Gas distribution system
      i. Removal of excess excavated material off-site
      j. Provide trench safety design as required for fire hydrant work.
   2. Systems shall start at a point approximately 5 feet beyond the exterior walls of the building and extend to termination unless otherwise indicated on the Drawings.

B. Related Documents: The Contract Documents, as defined in Division 1 Section - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections include the following:
   1. Division 01 Section “Information Available to Bidders - Geotechnical Report.”
   2. Division 22 Section “Connection to Building Systems.”
   3. Division 32 Section “Excavating, filling, grading of site.”

1.03 QUALITY STANDARDS

A. Meet requirements and recommendations of applicable portions of the Standards listed.
   1. Applicable publications of local governing authority
   2. American Society for Testing and Materials, ASTM.
   3. Texas Highway Department Standard Specifications for Construction of Highways, Streets, and Bridges, 1972, THD.
   4. Texas Trench Excavation Law.

1.04 SUBMITTALS

A. Division 1 Section - Submittal Procedures: Procedures for submittals.

B. Product Data: Submit copies of manufacturer's literature showing details of fabrication and installation of valves, vaults, clean-out boots, fire hydrants, flush hydrants, concrete pipe, joint materials, covers, grates and frames.

C. Shop Drawings: Submit manufacturer's data showing details of precast concrete structures related with site drainage.

D. Certification: Furnish Owner a certification from pipe manufacturer stating that pipe conforms to Specification requirements.

1.05 TESTING

A. Listed herein a minimum testing requirements. Cost for making these tests will be paid for by the Contractor.

B. Backfill: One laboratory test, TEX 114-E, for soil density shall be made for each type of soil used as backfill material. When a test has been made previously on similar soil, a duplicate test will not be necessary.

C. Reinforcing Steel: Furnish the Architect a certification from the steel fabricator or manufacturer stating that reinforcing steel conforms to Specification requirements.

D. Portland Cement Concrete: Contractor may use mix design currently being used which meets Specification requirements. In lieu of this, provide samples of materials proposed for use in Portland Cement concrete. Testing laboratory will determine that cement and aggregates meet requirements of these Specifications. Laboratory shall then prepare mix design which conforms to Specifications. New mix design will be required if materials are changed or if concrete does not meet strength or workability requirements.

E.

PART 2 - PRODUCTS

2.01 CONCRETE PIPES FOR STORM SEWER SYSTEM

A. Reinforced - ATSM C76 Class III Joints -
   1. Pipe of 12" diameter and over - Tongue and groove with neoprene or other approved gasket.
   2. Fittings and specials - Gasket type joints as required for pipe being connected.

2.02 CONCRETE STRUCTURES

A. Portland Cement: Shall be of a standard brand and shall conform to the latest ASTM designation C150, Type 1.

B. Aggregates for concrete: Fine or coarse aggregate and shall meet the requirements of THD, Item 421.

C. Concrete: Composed of Portland Cement, coarse aggregate, fine aggregate, water, mineral filler and/or admixtures, if permitted by the Architect. Concrete shall have a minimum compressive strength at 28 days of not less than 3000 psi and shall have a maximum water-cement ratio of 7.0 gallons per sack, minimum cement content of 5.0 sacks per cubic yard, and a slump from two (2) to three (3) inches. Measuring materials, batching, and mixing shall conform to ASTM Designation C94.

D. Reinforcing Steel: Conforming to ASTM Designation A615 of grade 40 or 60.

E. Cast Iron Rings, Covers, and Grates: Shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. Angles shall be filleted and arises shall be sharp and true. Surfaces shall be machined where indicated or where otherwise necessary to

secure true, flat surfaces. Covers and grates shall fit properly into frames, and seat uniformly and solidly.

1. Castings: Conforming to the following ASTM Designation:

Gray-Iron Castings	A48 Class 50
Malleable Castings	A47 35018
Ductile Iron Castings	A395 60-45-15

2. Trench Drain: Neenah Foundry Co. Type R-4990-C (Type A, B, or C Grate openings) with Type L Frame, or approved equal.

F. Inlets: Precast concrete inlets as indicated on the Drawings or approved equal.

G.

H.

2.03 CAST IRON PIPE

A. U.L. approved and accepted by State Fire Insurance Commission without penalty. Manufactured in accordance with Federal Specification WW-P-42, AWWA C1-6-53 (ASA A21.6) or AWWDA C108-53 (ASA A21.8), Class 150. Centrifugal cast pipe shall have metal thickness based on tensile strength of 18,000 pounds per square inch and modulus of rupture of 40,000 pounds per square inch. It shall be designed for five foot cover, trench condition B. For any variation in the above physical strength values, there shall be a corresponding variation in metal thickness based on the ASA approved formula in Manual for Computation of Strength and Thickness of Cast Iron Pipe (A21.1- 1939).

1. Joints: One of the following types:
   a. Push-On: AWWA C111 rubber gaskets and lubricant.
   b. Mechanical: AWWA C111 ductile iron or gray-iron glands, high strength bolts and nuts and rubber gaskets.
2. Gasket:
   a. American-Fastite Joint
   b. Lone Star-Bell-Tite Joint
   c. U.S.-Tyton
   d. or approved equal.
3. Fittings: AWWA C100-08 or C110-53 (ASA A21.10) bell and spigot type Class D, or AWWA C111-53 (ASA A21.11) mechanical joint type.
4. Lining: Outside tar coated, inside cement lined and sealed in conformance with AWWA C104-53 (ASA A21.4) except that cement lining may be half thickness in conformance with Federal Specification WW-P-421.
5. Solder Filler Metal: ASTM B32, Alloys Sn 95, Sn 94, ORE.

2.04 STEEL PIPE

A. Standard line pipe with plain ends, beveled for welding in random lengths, with welded fittings such as tube turns of same thickness as the pipe, unless otherwise required.

1. Flanges for connecting to valves - Forges steel welding neck designed for 150 PSI pressure, unless indicated otherwise.
2. Gaskets - 1/16" thick
   a. American Standard
   b. Rainbow
   c. or approved equal.
3. Tees for connecting service lines to main:

a. For new empty mains: Mueller Brass Co., H-17701 and 17500 or approved equal butt-welded type.
b. For existing mains in use: Mueller Brass Co., H-17570 or approved equal.
c.

2.05 PVC PIPING AND FITTING ASSEMBLY

A. Piping and Fittings: PVC plastic pipe AWWA C900, class 150 or 200 for water piping and provide with bell end and ASTM F 447 elastomeric seal gasket and plain end for PVC elastomeric gasket fittings. ASTM D 3034, SDR 35 for sewer piping.

B. Gaskets: ASTM F 477, elastomeric seal.

C. Solvent: ASTM D 2564, use type and procedures recommended by pipe manufacturer to make solvent-welded joints. Thoroughly clean pipe and fitting of dirt, dust, and moisture before applying solvent.

D. PVC to Metal Connection: Work metal connection first. Use a non-hardening pipe dope such as Permatex No. 2 on threaded PVC to metal joints. Use only light wrench pressure.

E. Threaded PVC Connection: Where required, use threaded PVC adapters into which pipe may be welded.

F. Plastic Underground Warning Tapes: Polyethylene plastic tape, 6 inches wide by 4 mils thick, solid green in color with continuously-printed caption in black letters “CAUTION - SEWER LINE BURIED BELOW.”

2.06 FIRE HYDRANTS

A. Conforming to AWWA Standard C 502-54 dry barrel type traffic mode with 5" minimum diameter valve opening. Mueller Brass Co. - A -24123, or approved equal.

2.07 TAPPING SLEEVE AND VALVE

A. Suitable for tapping cast iron water main under pressure and having a mechanical end joint. Kennedy Valve Company - 950X, or approved equal.

2.08 GATE VALVES

A. Water distribution - Designed for 150 pounds per square inch minimum working pressure. End design to conform to piping design. Clear waterway through valve shall equal nominal diameter of the valve. Valve shall have a 2" square operating nut turning counter clockwise to open with direction indicated by an arrow cast in the metal.
   1. Sizes less than 2" - Of brass conforming to Dereal Specifications WW-V-54, Type 1, Class B.
   2. Sizes 2" to 4” - Having cast iron body, brass-mounted, conforming to Fed Spec WW-X-58, Class A or AWWA standard C500, double disk type, non-rising stem.
   3. Sizes 4” and larger for fire protection - Nonrising Stem, UL 262, FM approved, iron body and bonnet with flange for indicator post, bronze seating material, inside screw, 175-psig (1200 kPa) working pressure, mechanical joint ends. Provide with flanged ends for pit installation.

B. Gas system - Cast iron wading type with cover marked "G" or "GAS"

C. Gas Distribution - Double disc type with parallel seat, non-rising stem, bronze mounted, with flanged end, designed for 176 pounds per square inch minimum working pressure. Mueller Brass Co. - A-2483-6, or approved equal.

2.09 STOP COCKS

A. Cast iron body, designed for 125 pounds per square inch working pressure. Mueller Lub O SEAL, H-11170 and H-11175, or approved equal.

2.10 VALVE BOXES

A. Water system - Of cast iron complete with lock-type cover operated by a special wrench and having the word "WATER" cast in the cover. Boxes shall be of the extension type with screw or slide-type adjustment and with flared base. Metal shall be 3/16" minimum thickness.

2.11 CLEAN OUT BOOTS

A. Cast -iron ferrule and countersunk brass cleanout plug, with round cast iron access frame and heavy duty, secured, scoriated cast iron cover shall be Trinity Valley 1684, or approved equal.

2.12 BACKFILL MATERIAL:

A. Borrow: Reused excavated or equal borrow material; low expansiveness, uniform in grade, free from organic materials, capable of being compacted to 95 percent maximum density at optimum moisture content; ASTM D-698.
   1. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accord with ASTM C136.

B. Bedding:
   1. Washed gravel, 1/4" to 1-1/2" in size.
   2. Screened pit run gravel passing 1-1/2" sieve and retained on 1/4" sieve.
   3. Pea gravel passing 5/8" sieve and retained.
   4.
   5.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall furnish all labor, tools, materials and incidentals required to complete the work.

B. The Contractor shall lay out all work included herein and shall determine the elevations of existing piping at all tap locations and furnish that data to the Owner for review of flow capacity.

3.02 EXCAVATION:

A. The Contractor shall excavate all materials encountered regardless of the difficulties encountered. The ditch shall be no greater in width or depth than is necessary to permit construction in accordance with the plans and specifications. The maximum width of trench at top of pipe without sheeting, shoring and bracing shall be the external diameter of the pipe plus eight inches.

B. The Contractor shall determine the need for sheeting and bracing to safeguard the workmen. When sheeting and bracing are necessary the trench or excavation shall be dug to such width that proper allowance is made for the space occupied by the sheeting. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressure exerted and protect all persons or property from injury or damage. Sheeting, shoring and bracing shall

not be left in place, but shall be removed in such a manner as not to endanger or damage new or existing structures. All holes or voids left by the removal of sheeting shall be backfilled.

C. Soft, Spongy or otherwise unstable material which will not provide a firm foundation for the pipe shall be removed and replaced with suitable material from the excavation or other sources approved by the Architect and shall be compacted as provided for in the Specifications. When unstable conditions are not corrected by the above means, the Contractor will be required to use rock, gravel, concrete or timber foundations. The type of foundation shall be determined by the Architect. There will be no extra compensation for this work.

3.03 BEDDING:

A. Trenches for pipe shall be excavated to a minimum depth of three inches below the grade of the outside of the pipe. Trenches shall then be filled up to and around the pipe exterior for at least 15 percent of its overall height with one of the following materials:

B. Other type of bedding shall be provided when designated on the Drawings.

C.

3.04 BACKFILL:

A. After the pipe has been installed, selected material from the excavation at a moisture content with which the required density can be obtained shall be placed equally along both sides of the pipe in layers not exceeding six inches loose depth. Care shall be taken to insure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted by hand or pneumatic tampers until the fill has reached an elevation 12" above the top of the pipe. The remainder of the backfill shall be placed in layers not exceeding 10" loose depth and shall be compacted by an approved method which will obtain the density of the adjacent undisturbed soil. Backfill for utilities under pavements and curbs and gutters shall be compacted in 6" layers to a density not less than 95 percent of maximum density at optimum moisture content of Standard Proctor Density. Water jetting will not be permitted.

1. Structures: Place backfill, as far as possible, as the work progresses, evenly on all sides of the structure. Remove forms, shoring, sheeting, bracing, etc., before starting to backfill and do not backfill against concrete until directed, which in general shall be at least 7 days after placement. Take care to prevent any wedging action of backfill against structure.

3.05 STORM SEWER SYSTEM

A. No pipe shall be laid until it has been inspected and approved. All pipe shall be laid and jointed in the dry. The pipe shall be laid up-grade beginning at the lower end of the line. Pipe shall be laid accurately to line and grade. When the entire pipe has been checked for line and grade, the body of the pipe shall be back-filled with enough earth or concrete on both sides to hold the pipe firmly in position.

B. Wye Connections: The connection of one pipe to another may be accomplished with a precast wye or by means of pipe-to-pipe connection. A pipe-to-pipe connection shall be made by cutting a hole in the larger pipe slightly larger than the outside diameter of the pipe to be connected. The smaller pipe to be connected shall not project into the larger pipe. A concrete collar not less than 6" thick and 6" wide shall be placed around the smaller pipe on the exterior surface of the larger pipe.

C. End-to-end Connections: Whenever a smaller pipe is jointed end-to-end to a larger pipe, the inside tops of the two pipes shall be matched. The void between the pipes shall be filled with cemented brick work or where this is not possible the void shall be filled with concrete or mortar. In either case, a concrete collar not less than 6" thick and 6" wide shall be placed over the joint.

D.

E.

F.

3.06 SANITARY SEWER SYSTEM

A. Pipe: As required per City specification.

B. Location: Where specific dimension is not shown, sewer shall be located at least 10' horizontally from any water supply or service line. Crossing above water lines: Construct gravity sewers which pass over water lines of Cast Iron Pipe for a distance of 9' each side of the crossing. No joint shall occur within 3' each side of the crossing.

C. Laying Pipe: Shape the bottom of the trench to give substantial uniform circumferential support to the lower fourth of the pipe. Lay pipe proceeding upgrade with the spigot ends of the bell and spigot pipe and the tongue ends of tongue and groove pipe pointing in the direction of flow. Lay each section true to line and grade in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow lines. As the work progresses, clear the interior of the pipe of all dirt and superfluous material. Where cleaning after laying is difficult due to small pipe size, keep a suitable swab or drag in the pipe and pull it forward past each joint immediately after the jointing is complete. When work is not in progress, plug the ends closing them by another approved method. If maximum width of the trench at the top of the pipe exceeds the specified dimension for any reason other than by direction, provide at no additional cost such concrete cradling, pipe encasement or other bedding as may be required to satisfactorily support the added load of backfill.

D. Infiltration: Leakage into the sewer shall not exceed 500 gallons per inch of nominal diameter per day per mile of pipe for any section between successive manholes. If the infiltration rate does not appear to be acceptable, measure the amount of leakage with a suitable weir or other device as directed. If the measured rate of infiltration exceeds the acceptable maximum, make correction in the system until it becomes acceptable.

E. Manholes: Construct manholes of precast concrete sections or of brick. Covers and frames shall be of cast iron. Invert channels shall be smooth and semi-circular in shape, conforming to the inside of the adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as the manhole size will permit. Changes in size and grade of the channels shall be made gradually and evenly. Form the invert channels directly in the concrete of the manhole base or by use of a half tile laid in concrete, or by laying full-section sewer pipe through the manhole and breaking out the top half after surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 1" per foot nor more than 2" per foot. Free drop inside the manhole shall not exceed 2'-6" measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels. Construct drop manholes whenever the free drop would otherwise be greater than 2'-6". In all manholes, provide steps of cast iron. Width of steps shall not be less than 10", set them approximately 15" apart and with alternate steps off-set 6". Rungs of 7/8" diameter wrought iron, galvanized after fabrication, may be

substituted for steps and may be installed without offset if the crossbar is not less than 14" long. Rungs shall be formed so that crossbar is sufficiently below plane of side bar to prevent foot from slipping off. Provide not less than 6-1/2" of toe room at each rung, measured from inside face of the crossbar.

F. Clean-outs and Stacks: Use pipe of the same material as the mainline and of 6" diameter unless shown otherwise. Provide removable standard pipe plugs.

G. Testing: Sewer mains will be checked to determine any displacement of the pipe after trench has been backfilled 2' above the pipe and compacted. Testing shall be with a light flashed between manholes or manhole location. If poor alignment or displacement or other defects are discovered, they shall be corrected as directed.

3.07 WATER DISTRIBUTION SYSTEM

A. Pipe Material and Preparation: Use PVC pipe. Before lowering pipe into trench, clean the interior of all foreign matter, inspect the pipe for defects. Defective, damaged or unsound pipe must be removed from the site.

B. Laying Pipe: The full length of each pipe section shall rest solidly upon the pipe bed with recesses excavated to accommodate bells and joints. Keep pipe interior clean and dry during laying operations. When work is not in progress, plug the ends or close them by another approved method. Do not lay pipe with bells facing in direction of laying. Do not lay pipe closer than 10' to a sewer. At cross-overs with sewers, no joint in the water line shall be closer than 9' from the cross-over point. Where possible, lay water lines 6' above sewers at cross-overs. Provide valves, plugs or caps, as required, where pipe ends are left for future connections. Deflections from a straight line or grade as required by vertical or horizontal curves of off-sets shall not exceed 6/D inches per lineal foot of pipe, between the center lines, extended, of any 2 connecting pipes. D represents the nominal pipe diameter in inches. If alignment requires deflection in excess of this limitation, use special bends or a sufficient number of shorter lengths of pipe to provide angular deflections within the limits.

C. Cutting Pipe: Use an approved type of mechanical cutter. Use wheel cutters when practical.

D. Pipe Joints: Install Mechanical Joints according to joint manufacturer's recommendations. Center the spigot in the bell, push the pipe in position and bring it into required alignment.

E. Valves: Where feasible, locate valves outside the area of roads and streets. Set valves plumb. Unless shown otherwise, provide a valve box over each outside gate valve. Box shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at its location. Center the box on the valve. Carefully tamp earth fill around the box to a distance of 4' on all sides or to the undisturbed trench face if less than 4'.

F. Fire Hydrants: Set the hydrant plumb and at such elevation that the connecting pipe will not have less cover than the distributing mains. Provide a concrete slab for the hydrant as required. Secure the hydrant to prevent it from blowing off the line with a concrete thrust block set between the back of the hydrant, opposite the pipe connections, and the vertical face of the trench. If the character of the soil is such that the hydrant cannot be wedged in this manner, provide bridle rods and rod collars of not less than 3/4" stock and protect them with a coating of acid resisting paint. Place at least 5 cubic feet of broken stone around the hydrant base to insure drainage. Thoroughly compact the backfill around hydrants to grade.

G. Flush Hydrants: Install where required so as to be flush with finished edge.

H. Meter and Meter Vault: Valves and fittings in meter vault shall be bolted flange type with ring gaskets.

I. Meter Vault: Per City Specifications.

J. Anchorage of Fittings: Anchor tees, bends and plugs in mains with thrust blocks formed of 2,500 p.s.i. 28 day strength concrete.

K. Sterilization: Sterilize each unit of completed distribution system, using chlorine, before it is accepted for domestic operation. If possible, flush the lines thoroughly before introduction of chlorinating material. The amount of chlorine shall be such as to provide a dosage of at least 50 parts per million. The chlorinating material shall be introduced into the system by an approved method. It shall remain in the system for a contact period of at least 24 hours and until the pressure test required below is complete. During this time valves in the system shall be opened and closed several times. After the contact period, flush the system with clean water until the residual chlorine content is depleted or not greater than 0.5 part million. Then take Bacteria samples as directed and submit them to the State Health Department Laboratory for analysis. Final results of the test shall indicate no chlorine bacteria present in the samples. Water mains shall meet State Health Department requirements before acceptance.

L. Testing: During sterilization contact period, test the system. Piping shall have been laid, joints completed and trench partially backfilled but leaving the joints exposed for examination. Unless otherwise required, expel air in the line and subject it to a hydrostatic pressure test of 50 pounds per square inch in excess of the anticipated static pressure at the points of reading when the system is pit in operation. Maintain the pressure for one hour. Exposed pipe, joints, fittings, valves and accessories shall be inspected. Tighten or remake defective joints. Replace defective material and repeat the test until results are satisfactory. Conduct open trench tests for 2 hours and covered trench tests for 24 hours. Provide all plugs, valves, pumps, equipment and labor necessary for conducting the tests. Assume responsibility for damage and/or contamination to existing connecting supply mains.

M. Special Requirements: Where conditions prevent the actual visible inspection of each joint or when the joints are made of a material other than lead such that leakage diminishes as the material in the joints ages, provide a calibrated gauge and meter to determine the quantity of water lost by leakage under normal operating pressure. To be accepted, any leakage (evaluated on a pressure basis of 150 pounds per square inch) must be less than 100 U.S. gallons per 24 hours per mile of pipe, per inch nominal diameter or pipe for pipe in 12 foot lengths, 75 gallons for pipe in 16 foot lengths, and varies proportionately for other pipe lengths. In calculating leakage, make allowance for added joints in the pipeline above the normal for unit lengths of pipe. Should any test of combined sections of pipeline disclose leakage greater than the acceptable limit, make repairs until the leakage is reduced to, at most, the acceptable limits.

3.08 CLEAN UP

A. Upon completion of the work covered by this Section, the Contractor shall clean up all work areas by removing all debris, surplus materials, and equipment from the site. The ground surface shall be restored to its original condition as nearly as possible.

3.09 PROTECTION

A. Properly protect existing utility lines shown on the Drawings from damage due to these operations. If damage occurs, satisfactorily repair it at no additional cost. If damage occurs to an unknown line, give immediate notification.

END OF SECTION 33 06 00

SECTION 33 11 13 - WATER SUPPLY LINES AND PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers furnishing all labor, materials, equipment, supplies, supervision and tools and performing all operations in connection with the installation of water supply lines, couplings and fittings of the types and pressure classes as shown on the Drawings or in the bid form.

1.02 RELATED SECTIONS

A. Section 31 23 33 - Excavation, Trenching and Backfilling for Utilities

B. Section 33 11 13.13 - Hydrostatic Testing of Water Lines

C. Section 33 11 13.19 - Conductive Trace Wire for Non-Metallic Pipe Installation

D. Section 33 13 13 - Sterilization of Water Lines

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ANSI - American National Standards Institute
   2. ASTM - American Society for Testing Materials
   3. AWWA - American Water Works Association
   4. NSF - National Sanitation Foundation

1.05 SUBMITTALS

A. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed. Shop drawings must show materials being offered, including dimensions and catalog data verifying the products meet the requirements of this section.

B. If HDPE pipe is used in the project, the Contractor shall submit two (2) copies of their HDPE fusion certificate of qualification for butt heat fusion joining of

polyethylene pipe. Certification training shall have been performed no more than 12 months prior to the start of construction.

1.06 QUALITY ASSURANCE

A. Pipe shall bear the NSF seal of approval for potable water pipe. Pipe manufacturer shall mark pipe with appropriate ASTM and/or AWWA designations.

B. Contractor shall notify Engineer not less than 24 hours before each load of pipe is to be delivered to the jobsite to allow for inspection. When a load of pipe is found to have inadequate wall thickness or tolerances greater than specified, randomly selected samples of the pipe shall be immediately sent to the National Sanitation Foundation, with instructions to check the pipe for compliance with not only National Sanitation Foundation specifications but other specifications for the specific contract. When the National Sanitation Foundation or other commercial laboratory selected concurs that the pipe does not meet specifications, it shall be immediately removed and replaced by the Contractor at no additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING

A. Handle and store pipe and appurtenances in accordance with manufacturer's recommendations. Interiors of pipe and appurtenances shall be kept clean prior to and during construction. Protect PVC pipe, HDPE pipe, and gaskets from excessive exposure to heat and sunlight.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Pipes and related products must conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and must be certified by an organization accredited by ANSI. Pipe shall be of domestic origin.

B. Encasement Wrap For Underground Metal Pipe, Fittings, Valves, And Appurtenances: All underground iron or steel materials shall be wrapped with 8 mil low density polyethylene or 4 mil high density polyethylene in accordance with ANSI/AWWA C105/A21.5.

C. PVC Pipe: PVC water lines shall be of the type designated on Drawings or in the bid form.

1. C-900 and C-905 PVC: C-900 PVC water line shall meet the requirements of AWWA C-900 (latest revision), "Polyvinyl Chloride (PVC) Pressure Pipe, 4

in. through 12 in., for Water Distribution." C-905 PVC water line shall meet the requirements of AWWA C-905, “Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14” through 48” , for water transmission and distribution”. Pipe shall be approved by the State Board of Insurance and Underwriters Laboratories for fire service without penalty. All DR18 pipe shall be pressure class 235 and all DR14 pipe shall be pressure class 305. Pipe shall bear the NSF seal of approval indicating that the pipe is suitable for conveying potable water.

a. Joints: Pipe joints shall be push-on type with one elastomeric gasket, or coupling type with two elastomeric gaskets furnished with each coupling. Joints and gaskets shall conform to AWWA C-900.
b. Fittings-Full Body: Unless otherwise shown on Drawings, fittings shall be cast or ductile iron mechanical joint type. Cast or ductile iron push-on type and mechanical joint type fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. Class 250 for 4" through 12" and Class 150 for 14" and larger unless otherwise shown on Drawings.
c. Fittings-Short Body: Unless otherwise shown on Drawings, ductile iron short body fittings may be used and shall be mechanical joint type. Push on and mechanical joint ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes.
d. Coating and Lining for Cast Iron and Ductile Iron Fittings: Fittings shall be asphalt coated outside in accordance with ANSI/AWWA C151/A21.51 except for above ground fittings which are to be painted. All uninsulated above ground D.I./C.I. fittings shall be painted. Fittings shall have cement mortar lining inside in accordance to ANSI/AWWA C104/A21.4.

2. PVC Pressure Pipe: PVC pressure pipe shall meet the requirements of ASTM D2241 "Specification for Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR) and shall bear the NSF seal of approval indicating that the pipe is suitable for conveying potable water. The following standards shall also apply to the installation of PVC pressure pipe:
   a. Joints: Unless otherwise shown on Drawings, pipe joints for 2" and larger pipe shall be push-on type conforming to ASTM D-3139, "Standard Specification for Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals." Joints for pipe smaller than 2" shall be solvent weld. Solvent weld joints shall meet the requirements of ASTM 2672, "Standard Specification for Bell End Polyvinyl Chloride (PVC) Pipe.
   b. Gasket: ASTM F-477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   c. Fittings: Fittings for 4" and larger pipe shall be cast iron or ductile iron. PVC fittings may be used for pipe 3" or smaller.
      (1) Ductile Iron and Gray Iron Fittings-Full Body: Unless otherwise shown on Drawings, fittings shall be mechanical joint type. Cast or ductile iron push-on type and mechanical joint type fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C11/A21.11. Class 250 for 4" through 12" and Class 150 for 14" and

larger unless otherwise shown on Drawings.

(2) Ductile Iron Fittings-Short Body: Unless otherwise shown on Drawings, ductile iron short body fittings may be used and shall be mechanical joint type. Push on and mechanical joint ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.21.11, Class 350 for all sizes.

(3) PVC Fittings: PVC fittings shall be Class 200 minimum rubber gasket type, except PVC fittings for pipe smaller than 2" shall be solvent weld. For special applications and with the Engineer's approval, solvent weld fittings may be acceptable for pipe size as large as 3".

d. Coating and Lining for Cast (Gray) Iron and Ductile Iron Fittings: Fittings shall be asphalt coated outside in accordance with ANSI/AWWA C151/A21.51, except for above ground uninsulated fittings which shall be painted. Fittings shall have cement mortar lining inside in accordance with ANSI/AWWA C104/A21.4.

e. PVC Material: ASTM D-1784, "Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds".

C. Ductile Iron Pipe: Unless otherwise shown on Drawings, ductile iron pipe shall be pressure Class 350 in accordance with ANSI/AWWA C151/A21.51.

1. Joints: Unless otherwise shown on Drawings, pipe joints shall be push-on type conforming to ANSI/AWWA C111/A21.11. Mechanical joint pipe shall conform to ANSI/AWWA C111/A21.11 and flanged joint pipe shall conform to ANSI/AWWA C115/A21.15.
2. Fittings-Full Body: Unless otherwise shown on Drawings, fittings shall be cast iron or ductile iron mechanical joint type. Mechanical joint and push-on fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on Drawings. Flanged fittings to be in accordance with ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on Drawings, both with one hundred twenty-five (125) pound template flanges. Flanged fittings shall have tapping bosses.
3. Fittings-Short Body: Unless otherwise shown on Drawings, ductile iron short body fittings may be used and shall be mechanical joint type. Mechanical joint and push-on ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes. Flanged fittings shall have full body dimensions.
4. Coating and lining for Pipe and Fittings: Pipe and fittings shall be asphalt coated outside in accordance with ANSI/AWWA C151/A21.51 except for above ground pipe and fittings which are to be painted. All uninsulated above ground D.I./C.I. fittings and pipe shall be painted. Pipe and fittings shall have cement mortar lining inside in accordance to ANSI/AWWA C104/A21.4.
5. Gaskets: Gaskets for push-on and mechanical joints shall conform to ANSI/AWWA C111/A21.11. Gaskets for flanged joints shall be 1/8 inch

thick rubber, either ring or full face, conforming to dimensions in Appendix to ANSI/AWWA C115/A21.15.

D. Steel Pipe: Steel pipe, 6 inches diameter and larger shall be Grade "A", seamless pipe conforming to AWWA C200 and shall have a minimum wall thickness as shown on Drawings.

1. Joints: Unless otherwise shown on Drawings, joints shall be butt welded field joints in accordance with AWWA C206. All welders assigned to apply metal arc welding to pipe joints under this specification shall have been tested under the American Welding Society "Standard Qualifications Procedures." The Contractor shall
   provide copies of certificates showing that all welders are qualified under the above standards.
2. Fittings: Steel flanges and fittings shall conform to AWWA C207 and C208.
3. Coatings and Lining for Pipe and Fittings: All interior and exterior surfaces of pipe and fittings shall receive shop applied coatings of Coal Tar Epoxy conforming to the requirements of AWWA C210. Weld joints and damaged coating shall be field repaired using materials and procedures recommended by the manufacturer of the coating used on the pipe.
4. Holiday Detection: Prior to installation, the coated pipe and fittings shall be holiday detected with a wet sponge holiday detector and all holidays shall be repaired in accordance with the requirements of AWWA C210.

E. HDPE Iron Pipe Size (I.P.S.) PE4710 Pipe: HDPE I.P.S. PE4710 water line shall meet the requirements of AWWA C-906 (latest revision), “Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in. (1,600 mm), for Water Distribution and Transmission” and shall be approved by the State Board of Insurance and Underwriters Laboratories for fire service without penalty. The material used shall meet the requirements of ASTM D3350 (with a minimum cell classification of PE445474C). All Class 200 pipe shall meet the requirements of DR 11 and Class 250 pipe shall meet the requirements of DR 9. Pipe shall bear the NSF seal of approval indicating that the pipe is suitable for conveying potable water.

1. Joints: Pipe sections shall be joined using heat fusion as specified by the pipe manufacturer.
2. Ductile Iron Fittings-Full Body: Fittings may be cast or ductile iron mechanical joint type. Cast or ductile iron push-on type and mechanical joint type fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. Class 250 for 4" through 12" and Class 150 for 14" and larger unless otherwise shown on Drawings.
3. Ductile Iron Fittings-Short Body: Ductile iron short body fittings may be used and shall be mechanical joint type. Push on and mechanical joint ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes.
4. Coating, Lining and Encasement for Cast Iron and Ductile Iron Fittings: Fittings shall be asphalt coated outside in accordance with ANSI/AWWA

C151/A21.51 except for above ground fittings which are to be painted. All uninsulated above ground D.I./C.I. fittings shall be painted. Fittings shall have cement mortar lining inside in accordance to ANSI/AWWA C104/A21.4.

5. Mechanical Joint Adapters: Mechanical Joint Adapters shall be manufactured from PE4710 (minimum cell classification of PE445474C) and shall conform to ASTM D3261.
6. HDPE Fittings: HDPE butt fusion type fittings may be used. HDPE butt fusion fittings shall be made of PE4710 (with a minimum cell classification of PE445474C) and shall conform to ASTM D3261 and AWWA C906 (latest revision). All fittings (molded and fabricated) shall have a pressure rating equal to the pipe unless otherwise specified in the Drawings. All fittings shall be fused by a qualified operator in accordance with ASTM F2620. Molded fittings shall be marked in accordance with ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206.

F. Copper Tubing: Copper tubing shall conform to the requirements of ASTM B-88, Type "K". Joints for underground work shall be compression-pattern, flared, for soft copper tubing and shall be made with fittings meeting approved standards. Tubing shall be cut off square and expanded with a proper flaring tool.

G. Insertable Valves: Insertable valves shall be extra heavy duty clamp on type valves manufactured by Hydra-Stop (A Division of ADS, LLC) or pre-approved equal. Valves shall have a standard valve nut and shall be capable of being installed under a line pressure of up to 150 psi without service disruption. Valve bodies shall be fabricated from Type 304 stainless steel. Valve gates shall be made of SBR rubber and valve stems shall conform to AWWA C500-93 (Section 3.12 specifications). Valves shall have a heavy duty top flange in conformance with ANSI A-105 (150 lbs). The number of turns to open for 4” to 16” diameter valves shall be no more and no less than 3 times the nominal valve diameter plus an allowance of 2 to 3 additional turns.

H. Gate Valves: Gate valves 2 inches and larger shall be iron-body, resilient rubber seat, non-rising stem and shall conform to AWWA C-509. Smaller valves shall be brass double disc with brass body, non-rising stem with square nut adapter and shall conform to AWWA C-500. Valves shall have ends as required for the piping in which they will be installed. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow cast in the metal indicating the direction of opening. Valves located inside structures shall be wheel operated and underground valves shall be nut operated. For nut operated valves installed with the nut more than 48" from finished grade, provide nut operator extension so nut operator is 48" or less below finished grade. Each valve shall have the maker's initials, pressure rating, and year of manufacture cast on the body. Valves 3 inches through 12 inches shall have a 200 psig working pressure

and valves 16 inches and larger shall have 150 psig working pressure. Prior to shipment from the factory each valve shall be tested by hydraulic pressure equal to twice the specified water working pressure. Gate valves shall be American Flow Control, Mueller, or preapproved equal.

I. Check Valves:

1. Swing Check Valves - Valves 2" in diameter and larger shall be iron body, bronze mounted, horizontal swing check valves with balanced weight and lever arm. They shall have a 150 p.s.i. working pressure and meet the requirements of AWWA C-508.
2. Silent Check Valves –
   (a) Wafer Style - Wafer style silent check valve shall be designed with semi-steel bodies, bronze seat, bronze plug and stainless steel spring. The valve plug must be center guided at both ends with a thru integral shaft and spring loaded for guaranteed silent shut-off operation.

   (b) The spring must be helical or conical. The seat and plug shall be hand replaceable in the field for ease of maintenance. The flow area thru the body shall be 3% greater than the cross-section area of the equivalent pipe size.

   (c) Check valve must be capable of silent operation when installed in vertical or horizontal position - flow up or flow down.

   (d) All materials of construction shall be certified in writing to conform to A.S.T. M. specifications as follows:

Body	Cast Iron	ASTM A126 Gr. B
Plug & seat	Bronze	ASTM B584 C83600
Spring	Stainless Steel	ASTM A276 T316
Exterior paint	Phenolic Primer	FDA Approved for Potable
	Red Oxide	Water Contact

   (e) The valve shall be suitable for use with 125# flanges. The valve shall be APCO Series 300, as manufactured by Valve and Primer Corporation, Schaumburg, Illinois, U.S.A., or approved equal.

   (f) Globe Style - Globe style silent check valves shall be designed with semi-steel bodies, bronze seat, bronze plug and stainless steel spring. The valve plug must be center guided at both ends with a thru integral shaft and spring loaded for guaranteed silent shut-off operation.

   (g) The spring must be helical or conical. The seat and plug shall be hand replaceable in the field for ease of maintenance. The flow area thru the body shall be 10% greater than the cross-sectional area of the equivalent pipe size.

(h) All materials of construction shall be certified in writing to conform to A.S.T.M. specifications as follows:

Body	Cast iron	ASTM A126 Gr. B
Plug & seat	Bronze	ASTM B584 C83600
Spring	Stainless steel	ASTM A276 T316
Exterior paint	Phenolic Red Oxide	FDA Approved for Potable Water Contact

The valve shall have 125# flanges. The valve shall be APCO Series 600, as manufactured by Valve & Primer Corporation, Schaumburg, Illinois, U.S.A., or approved equal.

J. Backflow Preventers: All types of backflow prevention assemblies shall meet the standards of AWWA and the Specifications of Backflow Prevention Assemblies contained in the Manual of Cross Connection Control, latest edition, published by Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California. Backflow preventers shall be as manufactured by Cla Val Company, Watts, or approved equal provided the backflow prevention assemblies meet the requirements contained herein. Rising stem gate valves will be acceptable for backflow preventer assemblies.

K. Butterfly Valves: Butterfly valves shall be cast iron body, rubber-seated, short body, pressure Class 150 meeting the requirements of AWWA C-504. Valves shall have gear operators unless noted otherwise on Drawings and shall have nut operators when underground and hand wheel operators above ground. The disc of the valve shall remain in any position in which it is set without moving, even when used to throttle flow. Butterfly valves shall be Dezurik, Pratt, Keystone, or approved equal. When called for on Drawings, provide pneumatic operator or electric motor operator as applicable. Electric motor operators shall be single phase, 120 VAC, 60 second operating time, 4 train limit switches for open/close service or for such other type service shown on the Drawings, EIM M2CP or Limitorque LY.

L. Plug Valves: Plug valves shall be cast iron body, stainless steel seat and Buna N plug. Plug valves to be by Dezurik, Pratt, Keystone or approved equal.

M. Miscellaneous Valves: Flush, blow off, air relief and pressure regulating valves shall be of the types and sizes and at the locations shown on the Drawings.

N. Fire Hydrants: Fire hydrants shall be dry barrel, compression type, 150 psi working pressure, traffic model, with 5-1/4" valve opening and shall meet the requirements of AWWA C-502. Pumper Nozzle shall match standard nozzle used on the Owner's system. Rotate fire hydrant barrel to face direction requested by

Engineer. Fire hydrants shall be American Flow Control, Mueller or preapproved equal.

O. Valve Boxes: Valves buried underground shall be provided with adjustable cast iron valve boxes of proper dimensions to fit over the valve and to extend to finished grade or slightly above as requested by Engineer. Valve boxes to have lids cast with the word "Water".

P. Water Meters: Water meters 1/2" through 2" shall be sealed register, displacement type and conform to AWWA C-700. Compound meters 2" to 10" shall conform to AWWA C-702. Meter size and type shall be as shown on Drawings.

Q. Tapping Sleeves: Tapping sleeves shall be stainless steel body with stainless steel flange, 200 psi working pressure with 125 pound outlet flange, Smith-Blair, Ford or preapproved equal.

R. Service Fittings: Tapping saddles, corporation stops and curb stops shall conform to AWWA C800. All corporation stops, curb stops and angle stops shall have the same rated pressure as the main line pipe to which the water service is attached. Electrofusion corp saddles for HDPE pipe, shall be made of PE4710 (with a minimum cell classification of PE445474C) and shall conform to ASTM F1055.

S. Joint Restraints. EBAA Iron Megalug, Series 1100 for ductile iron pipe, Series 2000 PVC for C-900 or IPS PVC pipe. Consult with Engineer for appropriate restraints for other pipe materials.

T. Insulation System: Two (2) inch thick rigid wrap as manufactured by E. O. Wood Co., Fort Worth, Texas or preapproved equal. Aluminum jacketing with integrally bonded moisture barrier as manufactured by Childers, 1100, 3003, 3105, 5005 or 5010 aluminum alloy, 0.016 inch minimum thickness. Mastic coating system to be Childers Vi-Cryl CP-11 and glass cloth membrane to be Chil-Glas #10.

U. Casing Spacers: Casing spacers shall provide electrical insulation between the carrier pipe and casing. They shall be made of high density polyethylene or other approved material. The casing spacers shall be "RACI" as manufactured by Public Works Marketing, Inc., Ranger II as manufactured by GPT, an EnPro Industries Company, or preapproved equal. The spacer shall be sized such that the bell of the carrier pipe will be held a minimum of one fourth (1/4) inch from the bottom of the casing, and the spacer O.D. shall not be less than the casing I.D. minus three fourths (3/4) of an inch. The design and type of spacer shall be suitable for the type, size, and weight of the carrier pipe and it's contents.

V. Hose Bibs with Vacuum Breakers: Hose bibs shall have brass bodies and be rated for 125 psi. Hose bibs shall be equipped with all brass vacuum breakers

rated for 125 psi. Hose bibs and vacuum breaker to be manufactured by Watts Industries, or approved equal.

PART 3 - EXECUTION

3.01 PREPARATION

A. Expose all underground utilities which may be in conflict with proposed water lines prior to installing new lines.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. General: All pipe shall have a cover of at least 42 inches from finished grade unless shown otherwise on Drawings. The pipe depth of cover shall not exceed 48 inches from finished grade unless acceptable to Engineer. No pipe shall be laid in water or when trench condition or weather is unsuitable for such work and pipe shall be kept clean before, during and after laying. Sanitary precautions shall be taken during water line installation as called for by AWWA Standards. Do not install pipe with radius of curvature less than the minimum recommended by pipe manufacturer. All buried iron or steel pipe, valve, fire hydrants, and appurtenances shall be poly wrapped.

1. PVC Pipe: PVC pipe shall be uniformly and continuously supported by stable soil. Bedding in the pipe zone from 4 inches below bottom of pipe up to 12 inches above top of pipe shall be hand placed select material free from rocks, organic refuse, or lumps greater than 1-1/2 inches, which will not break down readily when compacted. Bedding shall be placed in thin (approximately 4-inch) layers, moistened if necessary, and thoroughly compacted under and on each side of the pipe to provide support that is free from voids. The balance of the ditch may be machine backfilled unless otherwise shown on Drawings.
2. Ductile Iron and Steel Pipe: Lay pipe on firm earth foundation and carefully backfill to 6" over pipe with acceptable material free from clods, rocks, or other sharp debris which may damage protective coating or cause pipe to shift. The balance of the trench may be machine backfilled unless otherwise shown on Drawings.
3. Valves, Valve Boxes and Fire Hydrants: Install valves, valve boxes and fire hydrants plumb. Place valve boxes directly over valve stem. Before installation of valves or fire hydrants, clean all foreign material from interior and open and close valves to show that they are in good working order. Hand tamp backfill around valve boxes and fire hydrants out to undisturbed trench face. For all nut operated valves below ground, provide and install a valve operator extension on any valve that is installed where the operating nut is more than 30 inches below surrounding finished grade.

B. Conductive Trace Wire: Install conductive trace wire with all nonmetallic main water lines and with all service lines.

C. Separation of Water and Sewer Lines: The following criteria from Texas Commission on Environmental Quality regulations (See 30 TAC §290.44(e) in TCEQ regulations) shall be followed for water and sewer line separations: When water mains and sanitary sewers are installed, they shall be installed no closer to each other than nine feet in all directions and parallel lines must be installed in separate trenches. Where the nine feet separation distance cannot be achieved, the TCEQ guidelines in the paragraphs below shall apply.

1. New water line installation – parallel lines.
   a. Where a new potable water line parallels an existing, non-pressure or pressure rated wastewater main or lateral and the licensed professional engineer licensed in the State of Texas is able to determine that the existing wastewater main or lateral is not leaking, the new potable water line shall be located at least two feet above the existing wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the existing wastewater main or lateral. Every effort shall be exerted not to disturb the bedding and backfill of the existing wastewater main or lateral.
   b. Where a new potable water line parallels an existing pressure rated wastewater main or lateral and it cannot be determined by the licensed professional engineer if the existing line is leaking, the existing wastewater main or lateral shall be replaced with at least 150 psi pressure rated pipe. The new potable water line shall be located at least two feet above the new wastewater line, measured vertically, and at least four feet away, measured horizontally, from the replaced wastewater main or lateral.
   c. Where a new potable water line parallels a new wastewater main, the wastewater main or lateral shall be constructed of at least 150 psi pressure rated pipe. The new potable water line shall be located at least two feet above the wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the wastewater main or lateral.
2. New water line installation – crossing lines.
   a. Where a new potable water line crosses an existing, non-pressure rated wastewater main or lateral, one segment of the water line pipe shall be centered over the wastewater main or lateral such that the joints of the water line pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable water line shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral is disturbed or shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure rated pipe.

b. Where a new potable water line crosses an existing, pressure rated wastewater main or lateral, one segment of the water line pipe shall be centered over the wastewater main or lateral such that the joints of the water line pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable water line shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure rated pipe.

c. Where a new potable water line crosses a new, non-pressure rated wastewater main or lateral and the standard pipe segment length of the wastewater main or lateral is at least 18 feet, one segment of the water line pipe shall be centered over the wastewater main or lateral such that the joints of the water line pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable water line shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The wastewater main or lateral shall be embedded in cement stabilized sand (see clause (f) of this subparagraph) for the total length of one pipe segment plus 12 inches beyond the joint on each end.

d. Where a new potable water line crosses a new, non-pressure rated wastewater main or lateral and a standard length of the wastewater pipe is less than 18 feet in length, the potable water pipe segment shall be centered over the wastewater line. The materials and method of installation shall conform with one of the following options.

    (1) Within nine feet horizontally of either side of the water line, the wastewater pipe and joints shall be constructed with pipe material having a minimum pressure rating of at least 150 psi. An absolute minimum vertical separation distance of two feet shall be provided. The wastewater main or lateral shall be located below the water line.

    (2) All sections of wastewater main or lateral within nine feet horizontally of the water line shall be encased in an 18-foot (or longer) section of pipe. Flexible encasing pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The encasing pipe shall be centered on the water line and shall be at least two nominal pipe diameters larger than the wastewater main or lateral. The space around the carrier pipe shall be supported at five-foot (or less) intervals with spacers or be filled to the springline with washed sand. Each end of the casing shall be sealed with watertight non-shrink cement grout or a manufactured watertight seal. An absolute minimum separation distance of six inches between the encasement pipe and the water line shall be

provided. The wastewater line shall be located below the water line.

(3) When a new water line crosses under a wastewater main or lateral, the water line shall be encased as described for wastewater mains or laterals in subclause (2) of this clause (above) or constructed of ductile iron or steel pipe with mechanical or welded joints as appropriate. An absolute minimum separation distance of one foot between the water line and the wastewater main or lateral shall be provided. Both the water line and wastewater main or lateral must pass a pressure and leakage test as specified in AWWA C600 standards.

e. Where a new potable water line crosses a new, pressure rated wastewater main or lateral, one segment of the water line pipe shall be centered over the wastewater line such that the joints of the water line pipe are equidistant and at least nine feet horizontally from the center line of the wastewater main or lateral. The potable water line shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pressure rating of at least 150 psi. The wastewater main or lateral shall be embedded in cement stabilized sand (see clause (f) of this subparagraph) for the total length of one pipe segment plus 12 inches beyond the joint on each end.

f. Where cement stabilized sand bedding is required, the cement stabilized sand shall have a minimum of 10% cement per cubic yard of cement stabilized sand mixture, based on loose dry weight volume (at least 2.5 bags of cement per cubic yard of mixture). The cement stabilized sand bedding shall be a minimum of six inches above and four inches below the wastewater main or lateral. The use of brown coloring in cement stabilized sand for wastewater main or lateral bedding is recommended for the identification of pressure rated wastewater mains during future construction.

3. Water line and wastewater main or lateral manhole or cleanout separation. The separation distance from a potable water line to a wastewater main or lateral manhole or cleanout shall be a minimum of nine feet. Where the nine-foot separation distance cannot be achieved, the potable water line shall be encased in a joint of at least 150 psi pressure class pipe at least 18 feet long and two nominal sizes larger than the new conveyance. The space around the carrier pipe shall be supported at five-foot intervals with spacers or be filled to the springline with washed sand. The encasement pipe shall be centered on the crossing and both ends sealed with cement grout or manufactured sealant.
4. Location of fire hydrants. Fire hydrants shall not be installed within nine feet vertically or horizontally of any wastewater main, wastewater lateral, or wastewater service line regardless of construction.
5. Location of potable or raw water supply or suction lines. Suction mains to pumping equipment shall not cross wastewater mains, wastewater laterals, or wastewater service lines. Raw water supply lines shall not be installed within five

feet of any tile or concrete wastewater main, wastewater lateral, or wastewater service line.

6. Proximity of septic tank drainfields. Water lines shall not be installed closer than ten feet to septic tank drainfields.

D. Thrust Blocking and Joint Restraint: Concrete blocking and joint restraints shall be installed at all bends, tees, points where reducers or changes in pipe diameter occur, fire hydrants or valves and all plugged openings. Use concrete having compressive strength not less than 2,500 pounds per square inch. Place blocking against undisturbed solid ground, with area of bearing on pipe and on ground as required by manufacturer's recommendation for the type of soil encountered. Place blocking so that pipe and fitting joints will be accessible for repair. See detail sheet for minimum sizing.

E. Insulation: 4" diameter or smaller water lines and fittings and all sizes of valves installed above ground, shall be insulated to provide protection from freezing temperatures. The installation shall consist of a minimum 2 inch thick layer of Rigid-Wrap fiberglass insulation as manufactured by E.O. Wood Co., Fort Worth, Texas or a preapproved equal. All installation shall be weather proofed with Childers' aluminum jacketing or preapproved equal. The jacketing is to be manufactured from 1100, 3003, 3105, 5005 or 5010 aluminum alloy and have a minimum thickness of 0.016 inches. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation.

F. Encapsulation of insulation around fittings shall be accomplished utilizing a two coat vinyl-acrylic mastic coating system, Vi-Cryl CP-11, as manufactured by Childers or a preapproved equal. A glass cloth membrane, Chil-Glas #10, shall be embedded on to the first coat. The minimum dry film thickness of the vinyl-acrylic mastic shall be 1/16 inch. There shall be no voids or holidays and the mastic shall be trowelled, sprayed or wet brushed to a smooth even finish.

All of the above specified insulation, jacketing and encapsulation shall be installed in strict accordance with manufacturer's recommendations to provide a waterproof membrane around the insulation.

G. Casing Spacers: Casing spacers shall be installed on all carrier pipe which is installed inside a casing. Casing spacers shall be installed such that the distance between spacers does not exceed the maximum distance recommended by the manufacturer of the carrier pipe and by the spacer manufacturer dependent on potential weight of the carrier pipe full of water , except the distance between spacers shall not exceed five (5) feet. A casing spacer shall be installed within one (1) foot of the end of each joint of nonwelded carrier pipe, and two adjacent spacers shall be installed

on the carrier pipe at each end of the casing such that the last spacer is within one (1) foot of the end of the casing.

H. Hose Bibbs and Vacuum Breakers: Install hose bibs at the locations shown on the Drawings. Install vacuum breakers at all hose bib location on the supply side of the hose bib to prevent backflow of contaminated water into the water supply system.

I. Testing of Backflow Preventers: After installation, backflow preventers shall be tested by a backflow prevention assembly tester licensed in the State. Testing shall be in accordance with the Manual of Cross-Connection Control, latest edition, published by Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California; with the American Water Works Association – Recommended Practice for Backflow Prevention and Cross-Connection Control (Manual M14); and with local codes and requirements. Backflow preventers shall not be put into service until after passing the required testing.

3.03 REPAIR/RESTORATION

A. Sections of water line determined to be defective either prior to or during hydrostatic pressure test shall be replaced with sound materials at no expense to the Owner. No repair clamps will be allowed on new construction.

3.04 FIELD QUALITY CONTROL

A. Prior to final acceptance, hydrostatic pressure test and sterilize water lines according to the applicable sections.

3.05 ADJUSTING/CLEANING

A. Adjust all fire hydrants, valve boxes and meter boxes to proposed or existing grade as applicable. Upon completion of water line construction, all debris and surplus materials resulting from the work shall be removed from the project site.

END OF SECTION 33 11 13

SECTION 33 11 13.13 - HYDROSTATIC TESTING OF WATER LINES

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the procedure for hydrostatic pressure testing of all new water lines and appurtenances.

1.02 RELATED SECTIONS

A. Section 33 11 13 - Water Supply Lines and Piping

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. AWWA - American Water Works Association

1.05 SYSTEM DESCRIPTION

A. Furnish pump, pipe connections, gauges, meters, appurtenances and labor as required to perform pressure test and measure leakage on completed water line segments.

1.06 SCHEDULING

A. Perform hydrostatic pressure test on newly laid pipe or any valved section of piping after complete installation of pipe and all appurtenances, but prior to final sterilization or connecting to water system.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 PREPARATION

A. After new water line has been laid and backfilled, but prior to replacement of pavement, fill each valved section of pipe slowly with water. Before commencing test, expel all air from line. If necessary, tap pipe at points of highest elevation to expel all air. On completion of tests, taps to be tightly plugged with brass fittings.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Apply specified test pressure by means of pump connected to pipe. Provide means to measure or meter water pumped into the line to the nearest 0.1 gallon and a pressure gauge with a 6" minimum face and calibration marks at 1 psi intervals. At intervals during test, inspect route of pipe to locate any leaks or breaks.

3.03 REPAIR/RESTORATION

A. Remove and replace defective joints, cracks, or defective pipe or fittings. Should any test of sections of pipe disclose leakage greater than that specified, locate and repair defective joints or defective pipe until test proves that leakage is within specified allowance.

3.04 FIELD QUALITY CONTROL

A. Hydrostatic pressure test shall not be less than 1.25 times stated working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section. Test pressure shall not exceed the rated pressure of the pipe or valves at any time at any location on the segment being tested. Test pressure shall not vary by more than +/- 5 pounds per square inch for the duration of the test. Duration of test shall be two (2) hours.

B. The maximum allowable leakage for a test section shall not exceed the amount allowed or recommended by current formulas in AWWA C-600 and AWWA C-605.

$$Q = \frac{L\,D\,(P)^{(1/2)}}{148{,}000}$$

Q = quantity make up of water, in gallons per hour
L = length of pipe section being testing, in feet
D = nominal diameter of the pipe, in inches

P = average test pressure during the hydrostatic test, in pounds per square inch (guage)

END OF SECTION 33 11 13.13

SECTION 33 11 13.19 - CONDUCTIVE TRACE WIRE FOR NONMETALLIC PIPE INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the requirements for installation of a conductive trace wire with non-metallic pipe underground.

1.02 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.03 SYSTEM DESCRIPTION

A. Install electrically continuous trace wire with access points as described herein to be used for locating non metallic pipe with an electronic pipe locator after installation.

1.04 SUBMITTALS

A. Submit copies of shop drawings showing materials being offered and catalog data verifying the products meet the requirements of this section. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the number of copies that are to be returned to Contractor by Engineer after review is completed.

PART 2 - PRODUCTS

A. Trace wire to be twelve (12) gauge minimum solid copper with thermoplastic insulation recommended for direct burial. Wire connectors to be 3M DBR, or approved equal and shall be watertight and provide electrical continuity.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Trace wire shall be installed in the same trench and inside bored holes and casing with nonmetallic pipe during pipe installation. It shall be secured to the pipe as

required so that the wire remains adjacent to the pipe. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all new water valve boxes, water meter boxes, fire hydrants, sewer manholes, sewer cleanouts, gas valves and gas meter risers as applicable to the utility line being installed. At manholes, the wire shall be installed from the exterior of the manhole to the interior by installing a 24” loop in the wire underneath the manhole frame. A single branch wire shall be terminated at each access location (new water valve boxes, water meter boxes, etc. as previously listed), and the wires shall be spliced underground using the specified connector. For lines with more than 5 feet of cover, the wire shall be installed directly over the pipe at a depth of 5 feet. If the spacing of valves and meters is greater than one mile, install an intermediate trace wire access assembly as detailed on the Drawings. Where access points for trace wire on gas lines exceeds 500', install test lead boxes such that maximum access point spacing is 500'.

B. For termination of trace wire at locations other than a manhole, a valve box, or a water meter, provide a standard plastic water meter box and terminate the wire inside the meter box.

3.02 TESTING

A. Contractor shall provide line location (tracing) equipment (sending unit and receiver) and shall demonstrate in the presence of the Engineer that the trace wire functions properly throughout all of the work.

3.03 REPAIR/RESTORATION

A. The Contractor shall replace all trace wire that does not function properly or shall make repairs to make the trace wire function properly.

END OF SECTION 33 11 13.19

SECTION 33 13 13 - STERILIZATION OF WATER LINES

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the procedures for sterilization of water lines and appurtenances.

1.02 RELATED SECTIONS

A. Section 33 11 13 - Water Supply Lines and Piping

B. Section 33 11 13.13 - Hydrostatic Testing of Water Lines

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. AWWA American Water Works Association

1.05 SYSTEM DESCRIPTION

A. Furnish pump, pipe connections, gauges, meters, appurtenances and chlorinating agent to sterilize water lines and make bacteriological analyses to check effectiveness.

1.06 DELIVERY, STORAGE AND HANDLING

A. Store chlorinating agent in a safe place according to manufacturer's recommendation.

1.07 SCHEDULING

A. Perform final flushing and bacteriological test after successful hydrostatic test of line segment(s).

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Chlorinating agent to be liquid chlorine, sodium hypochlorite solution or calcium hypochlorite granules or tablets.

PART 3 - EXECUTION

3.01 PREPARATION

A. Remove, by flushing or other means, contaminating materials that may have entered the water line during construction. Where necessary, install temporary flush valves at the end of new lines for flushing and sampling prior to tying into existing system.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Application Procedure - Apply chlorinating agent by one of the following procedures:

1. Tablet Method - Place calcium hypochlorite granules or tablets in the water line at the upstream end of the first section of pipe, at the upstream end of each branch and at 500 foot intervals such that when the pipe is filled with potable water the dose will be a minimum of 25 mg/l for 24 hours. Fill pipe such that water velocity does not exceed one (1) foot per second.
2. Continuous Feed Method - Fill line with water, eliminate air pockets and flush water line at a minimum of 2.5 feet per second velocity to remove particulates. Feed chlorine water solution having a free chlorine concentration of 25 mg/l into line until entire line is filled with heavily chlorinated water. Retain chlorinated water in line for 24 hours after which time the free chlorine residual shall not be less than 10 mg/l.
3. Slug Method - Place calcium hypochlorite granules in the line during construction, completely fill the line to eliminate all air pockets, flush the line to remove particulates and slowly flow a slug of water dosed with chlorine to a concentration of 100 mg/l through the line such that all parts of the line and appurtenances will be exposed to no less than 50 mg/l of free chlorine for not less than 3 hours.

B. Chlorination of Appurtenances: Operate valves and hydrants several times while exposed to the required chlorine concentration to provide disinfection of appurtenances and pipe branches.

C. Final Flushing: In order to prevent damage to pipe and linings, flush heavily chlorinated water from system until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system.

D. Bacteriological Test: After final flushing, collect samples and test for presence of coliform organisms. Testing shall be performed by a laboratory approved by the TCEQ. A minimum of one sample shall be collected from each 1,000 feet of water line or at the next available sampling point beyond 1,000 feet as designated by the Engineer.

3.03 REPAIRS/RESTORATION

A. If initial disinfection fails to produce tests showing absence of coliform organisms, the new line may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated until satisfactory results are obtained.

3.04 FIELD QUALITY CONTROL

A. Testing for bacteriological quality shall be in accordance with Standard Methods for the Examination of Water and Wastewater.

END OF SECTION 33 13 13

SECTION 33 31 13 - SANITARY SEWERAGE SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This section applies to the construction of sanitary sewers, including installation of pipe, valves, fittings, manholes, cleanouts and other incidentals and testing of the installations. The work performed under this section applies to both gravity sewers and force mains.

1.02 RELATED SECTIONS

A. Section 31 23 33 – Excavation, Trenching and Backfilling for Utilities

B. Section 31 50 00 – Excavation Safety

C. Section 33 11 13.19 – Conductive Trace Wire For Nonmetallic Pipe Installation

D. Section 03 30 53 – Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in their entirety:
   1. ANSI - American National Standards Institute
   2. ASTM - American Society of Testing and Materials
   3. AWWA - American Water Works Association

1.05 SUBMITTALS

A. The Contractor shall submit to the Engineer the appropriate technical data for all components used in the construction of the sanitary sewerage system (i.e. pipe, fittings, manholes, valves, etc). For pipe, the Contractor shall submit copies of the pipe manufacturer's certification that the pipe is in full compliance with the standards applicable to the pipe specified and copies of manufacturer's data showing the physical properties of the pipe. The physical properties shall, as a minimum, include normal bursting pressure, manufacturer's maximum working pressure, physical dimensions, and tolerances. The Contractor shall submit four (4) copies of each submittal, which will be retained by the Engineer, plus the

number of copies that are to be returned to Contractor by Engineer after review is completed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall notify the Engineer of pipe delivery to the job site in advance in order to allow observation of the pipe by the Engineer prior to unloading of the pipe. Store pipe on a flat surface away from sunlight and heat. Do not stack bundles of pipe. Use a tarp to cover all pipe left for prolonged periods of time.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Pressure Rated PVC Pipe. Pressure rated PVC pipe, used for force mains or gravity lines, shall be polyvinyl chloride Type 1, Grade 1. The pipe shall meet AWWA specifications and bear the seal of the National Sanitation Foundation on each joint. The diameter and applicable commercial standard shall be shown on each length of pipe. The type of PVC pressure rated pipe required for the project shall be as shown on the Drawings.

1. Schedule 40 PVC Pipe. Schedule 40 PVC pipe shall conform to the requirements of ASTM D-1785. Joints for schedule 40 PVC shall be solvent weld with recessed bells. Pipe and fittings shall be made of PVC plastic having cell classification of 12454-B as specified in ASTM D-1784.
2. ASTM D-2241 PVC Pipe. Pipe other than schedule 40 PVC shall comply with the requirements of ASTM D-2241. The pressure rating of the pipe shall be SDR 21 (Class 200) unless otherwise shown on the Drawings or in the bid form. Joint seals for ASTM D-2241 PVC pipe shall conform to ASTM F-477. Pipe and fittings shall be made of PVC plastic having cell classification of 12454-B as specified in ASTM D-1784.

B. Non Pressure Rated PVC Pipe. Pipe for gravity sewers shall conform to ASTM D-3034 or ASTM F-675, SDR 26 unless otherwise shown on the Drawings. Pipe shall have fluid tight gasket type joints with joint bells formed integrally with the pipe. Joint seals shall conform to ASTM F-477. Pipe and fittings shall be made of PVC plastic having cell classification of 12454-B as specified in ASTM D-1784. The diameter and applicable commercial standard shall be shown on each length of pipe.

C. PVC Fittings. PVC fittings for the pipe shall be constructed of the same material as the pipe. Fittings shall be of the molded type or machined from extruded stock. PVC fittings for pressure rated PVC pipe conforming to ASTM D-2241 used for gravity lines shall have a minimum pressure rating of 150 p.s.i. PVC fittings for

pressure rated PVC pipe conforming to ASTM D-2241 used for force mains shall be rubber gasket and shall have a minimum pressure rating of 200 p.s.i. PVC fittings for Schedule 40 PVC pipe shall normally be Schedule 40 solvent weld, but rubber gasket fittings may be used in some applications. Fittings for ASTM D-3034 and ASTM D-2241 PVC pipe shall be push on type and have elastomeric seals and shall be compatible with the pipe. The seals shall meet ASTM F-477 for elastomeric seals. Fittings shall have smooth interior free of ridges or obstructions to sewer flow.

D. Ductile Iron Pipe. Ductile iron pipe shall be thickness Class 50 per ANSI/AWWA C151/A21.51, unless shown otherwise on the Drawings. Pipe joints shall be push on joint per ANSI/AWWA C111 unless shown otherwise. Interior flange pipe shall conform to ANSI/AWWA C115.

1. Coating, Lining and Encasement. Pipe and fittings inside wetwells or other structures and all above grade piping, valves, and appurtenances shall have outside coating in accordance with Section 09 90 00 Protective Coatings. All other pipe and fittings shall be asphaltic coated outside per ANSI/AWWA C151/A21.51 unless shown otherwise. Inside lining shall consist of a 30 mil dry film thickness of polyurethane high solids, high build two component coating (Corropipe II TX Five Minute Number 17115) as manufactured by Madison Chemical Industries, Inc., or 40 mil dry film thickness of amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment (Protecto 401 Ceramic Epoxy), or equal. Applicators of polyurethane and epoxy lining shall be approved by the pipe manufacturer. Encase pipe with 8 mil low density or 4 mil high density polyethylene in accordance with ANSI/AWWA C105/21.5.
2. Ductile Iron Fittings - Full Body. Fittings shall be cast iron or ductile iron push-on type conforming to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, unless shown otherwise on the Drawings. Mechanical joint fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on the Drawings. Flanged fittings to be in accordance with ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on Drawings, both with one hundred twenty-five (125) pound template flanges.
3. Ductile Iron Fittings - Short Body. "Short body" fittings shall be ductile iron push-on type conforming to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes, unless shown otherwise on the Drawings. Mechanical joint ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes. Flanged fittings shall have full body dimensions.
4. Gaskets. Flanged joint gaskets shall be of SBR or Neoprene rubber. Gaskets shall extend to the full flange with holes to match ANSI A21.10

or B16.1 Class 125 flange drilling. Gaskets shall be rated for 250 psi water working pressure as a minimum.

E. Concrete. All concrete shall meet the requirements specified in Section 03 30 53, Cast-In-Place Concrete.

F. Mortar. Mortar shall conform to the current specification for Mortar for Unit Masonry, ASTM Designation C270, Type S. Mortar shall be composed of two parts of fine aggregate thoroughly mixed with one part Portland cement and the amount of water required to produce a homogeneous mixture of such consistency that it can be easily handled and spread by trowel. Aggregate for the mortar shall meet ASTM C-144.

G. Manhole Covers. Manhole covers and rings shall be made of gray iron, ASTM A-48, Class 35B. The covers shall possess a tensile strength of not less than eighteen thousand (18,000) pounds per square inch. All casting shall conform to the shape and dimensions shown on the Drawings and shall be clean and perfect without defects of any kind. All sanitary sewer manhole covers must include the words "Sanitary Sewer". See detail drawings for required make and model of cover.

H. Cleanout Covers. Cleanout covers shall be made of gray cast iron. The cover shall be free from perforations and shall conform to the detail specified in the Drawings.

I. Fiberglass Manholes. Use manufactured reinforced fiberglass plastic as manufactured by Fluid Containment, Inc. formerly known as Owens-Corning Tanks Division, or preapproved equal. A traffic model designed for H 2O wheel loading is required. The base (bottom) of the manhole shall be pre-cast concrete meeting the requirements in these specifications for pre-cast concrete manholes and as detailed on the Drawings. The concrete base shall be coated per the requirements for concrete manholes.

J. Precast Concrete Manholes. Precast concrete manholes shall meet the requirements of ASTM C-478. Ring sections shall be of the diameter specified. Precast concrete manholes joint gasket connections shall be made with an O-Ring type rubber gasket meeting ASTM C361 and C443 as manufactured by Press-Seal Gasket, Inc. or approved equal. Precast manhole sections shall be specifically manufactured for O-Ring application. Installation shall be in accordance with the manufacturer's recommendations. A concrete waterproofing admixture with red dye shall be added to each manhole during the concrete batching process and shall be Xypex Admix C-1000R manufactured by Xypex Chemical Corporation dosed at 20 lbs. per cubic yard of concrete, Kryton KIM – HS (K-301) dosed at 2% by weight of cementitous material (including fly ash), or pre-approved equal. The use of the admixture (storage, handling, curing of concrete, addition to concrete) shall comply with the requirements set forth by the manufacturer.

K. Grade Rings. Precast concrete grade rings shall be used to adjust all types of manholes to final grade. Bricks shall not be used to adjust manhole grades.

L. Manhole Connections. Watertight, size-on-size resilient connectors allowing for differential settlement shall be used to connect pipe to new manholes. Water stop gaskets shall be installed on the pipe for connection to existing manholes. Pipe to manhole connectors shall conform to ASTM C-923.

M. Gate Valves. Non-rising stem gate valves used in a lift station shall have a position indicator. Gate valves 2-inches and larger shall be iron-body, resilient rubber seat, non-rising stem and shall conform to AWWA C-509. Gate valves smaller than 2-inches shall be brass double disc with brass body, non-rising stem with 2" square nut adapter and shall conform to AWWA C-500. Valves shall have the required ends for the piping in which they shall be installed. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be opened by turning counterclockwise. An arrow shall be cast in the metal of the operating nut or wheel to indicate the direction to open. Underground valves shall be nut operated and valves located in structures shall be wheel operated. For nut operated valves installed with the nut more than 48” from finished grade, provide a nut operator extension so the nut operator is 48” or less below finished grade. Each valve shall have the maker's initials, pressure rating, and year of manufacture cast on the body. Valves 2 inches through 12 inches shall have a 200 psig working pressure and valves 16 inches and larger shall have a 150 psig working pressure. Prior to shipment from the factory each valve shall be tested by hydraulic pressure equal to twice the specified water working pressure. Gate valves shall have the same exterior coating as the pipe and an 8 to 10 mil dry film thickness epoxy interior coating. Gate valves shall be American Flow Control, Mueller or pre-approved equal.

N. Check Valves. Check valves two and one-half (2-1/2) inches in diameter and larger shall be iron body, bronze mounted, horizontal swing check valves with balanced weight and lever arm designated for one hundred fifty (150) pounds working pressure, unless otherwise designated on the Drawings. Check valves shall have the same exterior coating as the pipe.

O. Plug Valves. Plug valves shall be manufactured by Dezurik or preapproved equal. Plug valves shall have the exterior coating same as the pipe and an 8 to 10 mil dry film thickness epoxy interior coating.

P. Valve Boxes. All valves buried in the ground shall be provided with cast iron boxes of proper dimensions to fit over the valve. The tops shall be complete with covers and adjustable.

Q. Shear Gates. Shear gates shall be all iron, Clow No. F-3000; Neenah Foundry Company, R-5005 Series; Olympic shear gate; or approved equal. Shear gates shall have lifting handle extension where required.

R. Combination Sewer Air Valves. Combination air valves for sanitary sewer force mains shall be A.R.I. Model D-025 or preapproved equal. All valves shall come equipped with backwash assemblies and shall be rated for sewer service.

S. Casing Spacers. Casing spacers shall provide electrical insulation between the carrier pipe and casing. They shall be made of high density polyethylene or of other approved material. The casing spacers shall be "RACI" as manufactured by Public Works Marketing, Inc., or approved equal. The spacers shall be sized such that the bell of the carrier pipe will be held a minimum of one fourth (1/4) inch from the bottom of the casing, and the spacer O.D. shall not be less than the casing I.D. minus three fourths (3/4) of an inch. The design and type of spacer shall be suitable for the type, size, and weight of the carrier pipe and it's contents.

T. Detector Tape. Detector tape for force mains must bear the label “PRESSURIZED WASTEWATER” repeated continuously in letters a minimum of 1.5 inches in height.

U. Inflow Protectors. Where required inflow protectors shall be RainGuard Inflow Protectors Model LFN-VHS as produced by L.F. Manufacturing Inc., or pre-approved equal. Inflow protector must be equipped with a strap and a vent hole.

PART 3 - EXECUTION

3.01 PREPARATION

A. Expose all underground utilities which may be in conflict with proposed sanitary sewer lines prior to installing new lines. If faults, caverns or subsidence are discovered during construction, halt work to allow features to be observed by Engineer. Construction may only be resumed when acceptable to Owner.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Pipe Laying and Jointing. Once the foundation has been prepared, pipe shall be laid with the spigot ends in the direction of the outlet or low end of the pipeline. The interior of the pipe shall be free from all dirt, joint material and foreign material as the work progresses and shall be clean upon its completion. Inside surfaces of adjacent sections of pipe shall be constructed in such a manner to provide the best possible flow conditions. Tight fitting stoppers or bulkheads shall be placed in the ends of all pipelines when the work has stopped, to prevent dirt or trash from entering the pipe.

B. PVC Pipe. Bedding of the pipe shall be as detailed on the Drawings for the laying conditions.

1. Solvent Weld Joints. When joints are made, the pipe fittings and couplings shall be at the same temperature. All joints shall be tested for a snug dry fit before solvent is applied. If the dry fit is such that the couplings are loose or if force is required to test dry fit, the pipe shall be rejected. A nonsynthetic brush shall be used to apply solvent cement in accordance with the manufacturer's recommendations. Lightly apply cement to the inside of the fitting and more generously to the outside of the pipe. The joint shall then be stabbed into the fitting and given a quarter turn. If sufficient cement has been used, a small bead will form between the pipe and the shoulder of the fitting. Remove this excess solvent. The joint shall not be moved until the cement weld has set. Fittings for service lines or laterals shall be assembled so that no strain is placed on the pipe during or after the backfill operation.
2. Push-On Joints. Before jointing, both bell and spigot ends shall be thoroughly cleaned and a lubricant supplied by the pipe manufacturer shall be applied according to the manufacturer's recommendations. Spigot end shall be beveled so it will not dislodge or damage gasket. To provide proper sealing of the joint, sufficient pressure shall be applied until reference mark on spigot is flush with end of bell.
3. Cutting Pipe. If it is necessary to cut the pipe, a fine tooth hacksaw shall be used and the burrs removed with a file. The outer surface of the pipe and the inner surface of the fittings shall be wiped with a clean cloth to remove all foreign matter and moisture before application of the solvent cement, for solvent weld joints. Bevel end of pipe per manufacturer's recommendations for push-on joints.

C. Ductile Iron Pipe. Bedding of the pipe shall be as detailed on the Drawings for the laying conditions.

1. Before jointing, both bell and spigot ends shall be thoroughly cleaned and a lubricant supplied by the pipe manufacturer shall be applied according to the manufacturer's recommendations. Spigot end shall be beveled so it will not dislodge or damage gasket. To provide proper sealing of the joint, sufficient pressure shall be applied until reference mark on spigot is flush with end of bell.
2. Mechanical Joints. Joints shall be made in a workmanlike manner, using rubber gasket seals, follower glands, and standard bolts. Overstressing of bolts to stop leaks resulting from poor installation practice will not be permitted.
3. Wall Sleeves. At all points where the pipe must pass through a wall of a structure, the Contractor shall furnish and install suitable sleeves and wall castings, unless otherwise shown on the Drawings. The wall sleeve or wall casting shall be a mechanical joint and/or flange fitting flush with the wall, with flanges tapped for studs.

D. Detector Tape. Install detector tape in the same trench as force main pipe along the top of the force main.

E. Conductive Trace Wire. Install conductive trace wire in compliance with Section 33 11 13.19 - Conductive Trace Wire For Nonmetallic Pipe Installation with all force mains and with gravity lines in Texas Department of Transportation (TxDOT) right-of-way.

F. Curved Alignment. For curved sewer lines, the Contractor shall not exceed the pipe manufacturer's recommended maximum deflection at each joint. Each joint shall be pushed "home" prior to deflecting the pipe and pipe shall not be stressed or bent to achieve curvature. The Contractor shall reduce the pipe lengths according to the manufacturer's recommendations if the radius of curvature cannot be achieved without exceeding the maximum deflection using standard length joints of pipe.

G. Valve Boxes and Operator Extensions. Valves buried in the ground shall be provided with cast iron valve boxes of proper dimensions to fit over the valve, and to extend to such elevation, at slightly above the finished ground line. Valve boxes shall be set vertical and centered with the valve stem. Provide and install a valve operator extension on any buried valve that is installed with the nut operator more than 48-inches below surrounding finished grade.

H. Thrust Blocking. Thrust blocking for pressure sewers (force mains) shall be in accordance with the pipe manufacturer's recommendation.

I. Embedment and Encasement. Embedment and encasement shall be placed at the locations shown on the Drawings and in conformance with Section 31 23 33 Excavation, Trenching and Backfilling for Utilities. If the maximum width is exceeded at any point, the Contractor shall use the next number of embedment higher than that designated on
the Drawings. The additional cost for using the higher type of embedment required because of over cutting will be at the expense of the Contractor.

1. Typical DIP Embedment. Unless otherwise shown on Drawings use Type 2 embedment in accordance with ASTM A746.
2. Typical PVC Embedment. Pipe shall be imbedded in sand or gravel with fines meeting the designation of Class I or II Soil per ASTM D-2321 compacted to a minimum of eighty-five (85) percent Standard Proctor. The embedment shall extend from six (6) inches below and on each side of the bell of the pipe to a point twelve (12) inches above the top of the pipe.

J. Precast Concrete Manhole Construction.

1. The manhole shall be constructed on a concrete foundation of the size and shape shown on the Drawings. The foundation shall be placed against undisturbed earth and the thickness shall be a minimum of eight (8) inches

below the bottom of the outside diameter of the sewer pipe or bottom edge of manhole section. If the manhole is over twelve (12) feet deep, then the foundation thickness shall be a minimum of twelve (12) inches below the bottom of the sewer pipe's outside diameter or bottom edge of manhole section. The bottom section ring shall be embedded in a concrete foundation to a minimum depth of six (6) inches. Precast manhole bottoms may be used if cast as an integral part of the bottom ring.

2. Pipe connections to a new manhole shall be made with watertight, size-on-size resilient connectors that allow for differential settlement and must conform to ASTM C-923. Pipe connections to an existing manhole shall be made with approved waterstop connectors or with connectors conforming to ASTM C-923.
3. Manholes shall be installed as one basic unit. The Contractor is responsible for verifying the correct manhole depth before construction. Top of precast portion of manhole shall not be less than twelve (12) inches nor greater than eighteen (18) inches from final grade. The Contractor is responsible for the correct depth of manholes relocated in the field because of unforeseen conflicts. Manhole tops shall be adjusted with precast concrete rings and be set as follows:
    a. Undeveloped Areas. Manhole tops shall be set one (1) inch higher than the existing elevation of natural ground or other final grade, unless shown otherwise on the Drawings.
    b. Developed Areas. Manhole tops shall be set flush with paved surfaces and one (1) inch higher than shoulder and/or proposed final grade elevations in easement or other unpaved areas. Where manholes are located in a ditch bottom, set manhole top a minimum of twelve (12) inches above the ditch bottom and reshape the ditch around the manhole.
4. Backfill around manholes and drop connections immediately after mortar and concrete have set. Place backfill around the manhole evenly in six (6) inch layers and in such a manner that no torque is applied to the manhole. For manholes in paved areas backfill around manholes shall be of same material and compaction as specified for sewer line in paved areas. Where a proposed sewer line connects to an existing manhole at or near a manhole invert, reshape the invert of the existing manhole so that no turbulence is created in the manhole as a result of the connection.
5. Precast concrete rings shall be used to adjust the top of the manhole to the proposed grade if necessary.

K. Cast-in-Place Manholes. Manholes shall be constructed of concrete conforming to applicable section. Manholes shall be poured in place as shown on the plan sanitary sewer detail sheet. The foundation shall be placed against undisturbed earth and shall be a minimum of eight (8) inches thick below the bottom of the sewer outside diameter, except if the manhole is over twelve (12) feet deep make the foundation twelve (12) inches thick below the bottom of the sewer pipe outside diameter. The manhole foundation, walls and cone section shall be

constructed in a single continuous monolithic concrete pour.

L. Fiberglass Manholes. Construction of fiberglass manholes shall follow the general procedures for precast concrete manholes.

M. Construction Methods For All Manholes.

1. Manhole Connections. Watertight, size-on-size resilient connectors allowing for differential settlement shall be used to connect pipe to new manholes. Water stop gaskets shall be installed on the pipe for connection to existing manholes and shall be grouted in place with non-shrink grout having a minimum thickness of one (1) inch around the gasket.
2. Manhole Inverts. The bottom of the manhole shall be provided with a "U" shaped channel that is a smooth continuation of the inlet and outlet pipes. For manholes connected to pipes less than fifteen (15) inches in diameter, the channel depth shall be at least half the largest pipe diameter. For manholes connected to pipe greater than 15 inches but less than 24 inches in diameter, the channel depth shall be at least three-fourths of the largest pipe's diameter. For manholes connected to pipes greater than twenty-four (24) inches in diameter, the channel depth shall be at least equal to the largest pipe diameter. Invert flow channels shall be on an even slope from pipe to pipe. The bench provided above the channel shall be sloped at a minimum of 0.5 inch per foot. Where sewer lines enter the manhole higher than twenty-four (24) inches above the manhole invert, the invert shall be filleted to prevent solids deposition and the pipe entering the manhole must have a drop pipe. Where the main sewer (lowest line) passes straight through the manhole and the degree of deflection of the main sewer is less than five (5) degrees, and no other line or stub out is shown entering the manhole below the center line of the main sewer, lay the sewer continuously through the manhole. After the manhole walls have been completed, cut out and remove the top half of the barrel of the sewer pipe that was previously laid through the manhole. Use concrete with one (1) inch mortar topping and construct the remainder of invert as shown on Drawings. Where the main sewer (lowest line) alignment deflects greater than five (5) degrees at the manhole or where another sewer or stub out enters at or below the center line of the main sewer, terminate the main sewer pipe laying in such a manner that the ends of pipe protrude inside of the manhole. The invert shall be constructed with concrete and topped with one (1) inch of mortar. The invert shall be shaped to allow for a smooth flow across the floor of the manhole and slope the side as required to prevent deposition of solids.
3. Stubs Outs. Stub outs shall be installed to line and grade where shown. One (1) full joint of pipe or such other length as shown on the Drawings, of the size indicated, will be used for the stub out. The stubbed out pipe shall terminate with the bell end of the pipel Seal the stub out with a plug. The plug shall be installed in such a manner as to prevent seepage or leakage through stub outs. The plug shall be installed such that it may

easily be removed in the future without damaging the bell or groove end of the stub out.

4. Contractor shall meet all OSHA requirements relating to entry into confined spaces prior to personnel entering manhole for any reason.

N. Cleanout Structures. Cleanout structures shall be constructed where shown on the Drawings and as specified. Cleanouts shall consist of line size pipe laid on an angle on undisturbed natural ground. Machine tamp all backfill around and above the pipe in layers six (6) inches or less in depth so that no settlement shall occur after the cleanout is constructed. Other construction details shall conform to the cleanout detail shown on the Drawings.

O. Connections.

1. Drop Connections. Drop connections on manholes shall be constructed according to the Drawings and these specifications. The connection shall include the indicated fittings and necessary backfill material.
2. Service Connections. Standard service connections shall consist of a sewer style tee or wye and forty-five (45) degree bend as detailed on the Drawings and the necessary four (4) inch diameter PVC sewer pipe to reach the property line, or be plugged and sealed at the end. The Drawings may require a larger service line. Install a larger service line when shown on the Drawings. If required, the Contractor shall raise the lateral by means of a steeper grade from the main. Locations of the service outlets and the depth to the top of the lateral pipe, if depth is not shown on the Drawings, will be designated at the time of construction. Minimum depth of cover over the end of the lateral pipe shall be five (5) feet.

P. Separation Distances. The following are separation distances that shall apply between potable water and wastewater treatment plants, and water lines and sanitary sewers.

1. Potable Water Treatment Plant Separation. Sanitary sewers located within 50 feet of any underground treatment plant units shall be constructed of ductile iron or PVC with a minimum pressure rating of 150 pounds per square inch and watertight joints.
2. Water Line / New Sewer Line Separation. Sanitary sewers shall not be installed within nine (9) feet, in all directions, to existing water lines. Sewer lines parallel to water lines must be installed in separate trenches. If the nine (9) feet separation distance cannot be achieved, the following guidelines apply.
    a. Where a sanitary sewer parallels a water line, the sewer shall be constructed of cast iron, ductile iron or PVC meeting ASTM specifications with a pressure rating of 150 psi for both the pipe and joints. A minimum vertical distance of two (2) feet and a minimum horizontal distance of four (4) feet between the outside diameters of the pipes is required. The sewer shall be located below the water line.

b. Where a sanitary sewer crosses a water line, and the sewer is constructed of cast iron, ductile iron or PVC with a minimum pressure rating of 150 psi, an absolute minimum distance of six (6) inches between the outside diameters shall be maintained. The sewer line shall be placed below the water line, and one length of the sewer pipe must be centered on the water line.

c. Where a sewer line crosses under a water line and the sewer line is constructed of ABS truss pipe, similar semi-rigid plastic composite pipe, or concrete pipe with gasketed joints, a minimum separation distance of two (2) feet must be maintained. The initial backfill shall be cement stabilized sand (two or more 80 pound bags of cement per cubic yard of sand) for all sections of sewer within nine feet of the water line. This initial backfill shall be from one quarter diameter below the centerline of the pipe to one pipe diameter (but not less than twelve (12) inches) above the top of the pipe.

d. Where a sewer crosses over a water line all portions of the sewer within nine (9) feet of the water line shall be constructed of cast iron, ductile iron, or PVC pipe with a pressure rating of at least 150 psi using appropriate adapters. In lieu of this procedure, the sewer pipe may be encased in a joint of 150 psi pressure class pipe at least eighteen (18) feet long and two (2) nominal sizes larger than the sewer pipe. The carrier pipe shall be supported at five (5) foot intervals with spacers or be filled to the springline with washed sand. The encasement pipe should be centered on the crossing and both ends sealed with cement grout or a manufactured seal.

3. Water Line / Manhole Separation. If the sanitary sewer manholes and the connecting sewer cannot be made watertight and tested for no leakage, then a minimum horizontal separation distance of nine (9) feet must be provided between the manhole and the water line. However, where a 9' separation between sanitary sewer manholes and a water line cannot be achieved, the Contractor must construct the manhole to be watertight (leak free).

Q. Casing Spacers: Casing spacers shall be installed on all carrier pipe which is installed inside a casing. Casing spacers shall be installed such that the distance between spacers does not exceed the maximum distance recommended by the spacer manufacturer dependent on potential weight of the carrier pipe and casing, both full of water, <u>except</u> the distance between spacers shall not exceed seven (7) feet. A casing spacer shall be installed within one (1) foot of the end of each joint of nonwelded carrier pipe, and two adjacent spacers shall be installed on the carrier pipe at each end of the casing such that the last spacer is within one (1) foot of the end of the casing.

3.03 FIELD QUALITY CONTROL

A. Test For Deflection of PVC Pipe. All PVC pipe installed for gravity sewers will

be tested for deflection according to this specification after the pipe segment has been in place for a minimum of thirty (30) days. Maximum allowable deflection shall not exceed five percent (5%) of the inside diameter of the pipe. The inside diameter shall be the average outside diameter minus two (2) minimum wall thicknesses for outside diameter controlled pipe or the average inside diameter for inside diameter controlled pipe. A rigid "go, no-go" mandrel will be used to check the deflection of an installed section of PVC pipe. The mandrel will be sized so that it will not "go" when encountering a deflection that is greater than permissible. The mandrel must be of such design as to minimize the possibility of it being hung up in the pipe by silt or other residues. A design sized to permit up to five percent (5%) deflection in pipe is shown in Figures 3.03A & 3.03B. Table 3.03A showing the required dimensions of mandrels for various pipes is attached. Suggested instructions for its use are as follows:

1. Completely flush the line making sure the pipe is clean of any mud or debris that would hinder the passage of the mandrel.
2. During the final flushing of the line, attach a floating block or ball to the end of the mandrel pull rope and float the rope through the line.
3. Once the rope is threaded through the line, connect the pull rope to the mandrel and place the mandrel in the entrance of the pipe.
4. Connect a retrieval rope to the back of the mandrel to pull it back, if necessary.
5. Remove all slack in the pull rope and place a tape marker on the rope at the ends of the pipe where the mandrel will exit, determining the location of the mandrel in the line.
6. Draw the mandrel through the sewer line by hand pulling only. If any irregularities or obstructions are encountered in the line, the Engineer should establish the corrective action, if required.
7. If a section with excessive deflection is found, locate it; dig down and uncover the pipe; inspect the pipe, if any damaged pipe is found, replace it; if pipe is not damaged, replace and thoroughly tamp the haunching and initial backfill; replace remainder of backfill.
8. Retest this section for deflection a minimum of thirty (30) days after completing the repair.

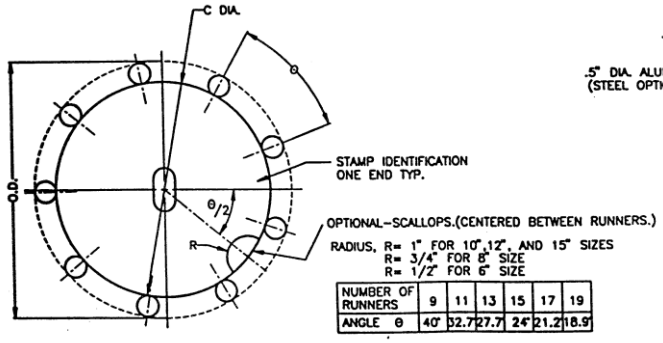


Figure 3.03 A

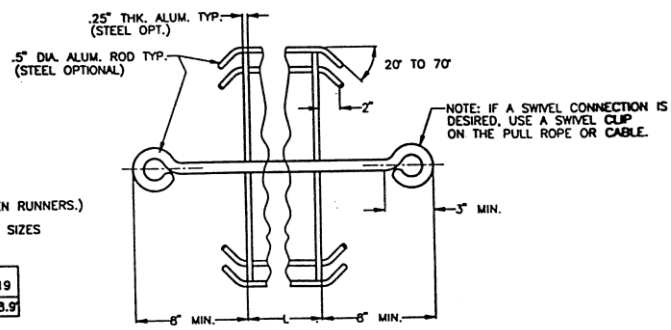


Figure 3.03 B

B. Testing Pressure Sewers For Leakage. All pressure sewers shall be tested for leakage with a hydrostatic test to be completed in the presence of the Engineer or his representative. Leaks demonstrated by the tests are to be repaired at the expense of the Contractor.

1. Performance. Newly laid pipe or any valved section of piping shall be subjected for four (4) hours to a hydrostatic pressure test of 50 p.s.i. above normal working pressure at point of test, but not less than 75% of the rated pressure of the pipe. Test pressure shall not exceed the rated pressure of the pipe at any time at any location on the segment being tested. Test pressure being applied to the line shall not be allowed to vary more than 5 pounds per square inch for the duration of the test. The maximum permissible leakage is 10.0 gallons per inch diameter per mile of pipe per day.
2. Execution. Fill test section of pipe with water and expel the air from the pipe. Apply the specified test pressure by means of a pump connected to the pipe. The Contractor shall furnish the necessary pump, pipe connections, gauge and meter and shall conduct the test. If force main is tapped to perform test, plug taps with brass fittings upon completion of test.
    a. Inspect the route of the pipe during the test period to locate any leaks or breaks. The Contractor shall replace any cracked or defective pipe, fittings or valves disclosed in the pressure test.
    b. When the four (4) hour test period is completed, bring the pressure in the pipe up to the specified test pressure and determine the amount of water lost during the test. No piping installation shall be accepted until the leakage amount is less than 10.0 gallons per inch diameter per mile of pipe per day. Should any test of combined sections or individual sections of pipe show leakage greater than the specified limit, the Contractor shall locate and repair the defective joints or defective pipe until the test proves that the leakage is within the specified allowance.

C. Testing Gravity Sanitary Sewers For Leakage. The Contractor shall test all gravity sewer lines using either the infiltration method, exfiltration method, or the low pressure air test, in the presence of the Engineer or his representative. Additionally, all new manholes shall be tested. The Engineer or his representative shall be notified no later than the preceding day, of the date and approximate time the tests will be made. Sewers shall not show leakage of more than fifty (50) gallons per inch diameter per mile of pipe per twenty-four (24) hours at a minimum test head of two (2) feet above the crown of pipes at the upstream manhole using the infiltration or exfiltration test except for pipes installed in the 25 year flood plain, which shall show leakage less than 10 gallons per inch diameter per mile of pipe per twenty four (24) hours. An infiltration test must be used when pipes are installed below groundwater level. For the air test, leakage shall not exceed the amount specified herein for the length and diameter of the pipe tested. The Engineer may vary the procedures for "Infiltration Test,"

"Exfiltration Test," and "Air Test" provided the methods used give an accurate measurement of the leakage.

1. Preparation for Testing. The Contractor shall supply all water for the tests, all equipment and labor necessary to convey the water into the sewer, and all labor and equipment to install test plugs, and other incidental work in conducting the tests and the cost thereof shall be included in the price for constructing the sewer. The Contractor shall supply the test plugs and the risers for the tests and will conduct the tests.
    a. Before testing is observed by the Engineer, sewers shall be completely backfilled, except for the stacks, but not necessarily water tamped. The Contractor may make preliminary tests with a minimum of eighteen (18) inches of backfill over the pipe to determine if any repairs are necessary. These tests are for the Contractor's information and shall not be performed in lieu of the tests to be observed by the Engineer. These line tests will be made between the inlet side of the downstream manhole and the outlet side of the next upstream manhole.
    b. Unless the Contractor has been notified that the tests will be made by the infiltration method, he shall leave the tops of stacks exposed and unplugged until after the leak test has been made. If a stack terminates below the test level, they shall be temporarily extended upward by installing an additional length of pipe in the top.
    c. The Contractor shall provide suitable means to determine the groundwater level at any time until the testing is completed. As an example, a pipe not less than three (3) inches in diameter, such as a downspout pipe, closed at the bottom and perforated for at least the lower three (3) feet, with the perforations wrapped with at least two (2) thicknesses of filter fabric, set in the trench prior to backfilling. These pipes shall than be removed or cut off at least two (2) feet below the ground after testing has been completed. Prior to removal, the pipes shall be protected against damage and earth or other material excluded therefrom. Generally one pipe shall be installed in each run of pipeline between manholes.
    d. Stubs or house connections connected to the section being tested for leakage which are below the test water level, will be considered in computing the allowable leakage but the Contractor will not be held responsible for excess leakage in sewers not laid by him which have been connected to the lines being tested. The Engineer may request individual stubs or house connections in the system that were constructed under this contract to be tested. Prior arrangements for access to the ends of the pipe will be made for these tests.
2. Infiltration Test. For the Infiltration Test, all pumps must be stopped and the groundwater allowed to return to its normal level and to remain so for at least 24 hours. Before the test is started, the pipe will be filled with water to a depth that will cause leakage to flow at a uniform rate through

an opening in the plug in the downstream end of the section of sewer being tested. Leakage will be determined by measuring the flow through the opening in the downstream plug during a given time. Five measurements will be taken. The average of the measurements will be used. If one of the five measurements varies by more than fifty percent (50%) of the other four, then that measurement will be discarded, except for the last measurement taken. If the results of the tests are satisfactory, but the last of the five measurements shows leakage in excess of that permitted, tests shall be continued to determine if additional leaks may have developed during testing.

Size of Pipe	Allowable Leakage*, Gal. Per Minute Per 100 Ft.
6"	0.0039
8"	0.0053
10"	0.0066
12"	0.0079
15"	0.0099
18"	0.0118
21"	0.0138
24"	0.0158
27"	0.0178
30"	0.0197
36"	0.0237

*Equivalent to 50 gal. per inch diameter per mile per 24 hours

3. Exfiltration Test. In order to permit absorption by the pipe, the Contractor may keep the pipe full of water for 24 hours prior to the test. The Engineer shall be notified by the Contractor before backfilling is completed that the pipe will be filled and will be given 48 hours before the test to allow time for filling and soaking the pipe. At least two (2) hours before the tests start, the water will be bled off below the level of the top of the pipe at its lower end and allowed to remain so until the water level remains static at this level or continues to fall. The test shall be made in the following manner.
   a. A watertight plug, equipped with a pipe riser will be inserted and braced in the inlet opening in the downstream manhole and a similar plug equipped with a suitable vent pipe that will permit the escape of air in the pipe at its upper end, will be inserted and braced in the outlet in the upstream manhole. Fill the sewer and riser with water up to a level either four (4) feet above the crown of the sewer pipe at its lower end or two (2) foot above the crown of the sewer pipe at its upper end, whichever is higher, plus the vertical distance from the invert of the sewer at its lower end up to the level of the groundwater where such groundwater exists above the invert of the sewer.

b. The sewer will be filled with water as a continuous operation, as rapidly as the supply will permit, and the test measurement will be started as soon as the water is at the required level. This will be completed in not less than two (2) hours for sewers twelve (12) inches or smaller, not less than three (3) hours for sewers fifteen (15) inches through twenty-four (24) inches and not less than four (4) hours for larger sewers. A measurement of the water level will be recorded at each minute for five (5) minutes or until the level has dropped twelve (12) inches, whichever occurs first. The water will then be brought back to the required level and the test shall be repeated until five (5) such tests have been performed. Use the average of these results, discarding any of the five (5) observations that varies by more than fifty percent (50%) form the average of the other four (4) except for the last one. If the results of the tests are otherwise satisfactory, but the last of the five (5) measurements shows leakage in excess of that permitted, the tests will be continued to determine if additional leaks may have developed during testing.

c. The total leakage in cubic inches shall be the total cross-sectional area in square inches of the inside of the two (2) risers and of any stacks in the sewer multiplied by the drop in water level in inches.

Table For Measuring Leakage in Sewers

Diameter of Riser Or Stack	Volume Per Inch of Depth Cu. Inch	Gallons
1"	0.7854	0.0034
2"	3.1416	0.0136
2-1/2"	4.9087	0.0212
3"	7.0686	0.0306
4"	12.5664	0.0544
5"	19.6350	0.0850
6"	28.2743	0.1224
8"	50.2655	0.2176

4. Air Test. The air test shall be performed as follows.

a. To perform the air test, all the water should be flushed and drained from the line being tested prior to beginning the test. All pipe outlets, especially laterals and services, shall be plugged. Air shall be added until the internal air pressure of the sewer line is 4.0 psi greater than the pressure exerted on the pipe by the groundwater above the pipe. Allow the air pressure to stabilize after it has reached 4 psig. As the air temperature stabilizes, the air pressure will normally drop. When the pressure has stabilized at 3.5 psig, allow the pressure to drop to 2.5 psig. The time it takes the pressure to drop from 3.5 psig to 2.5 psig shall be recorded. If the

time it takes the pressure to drop exceeds the time permitted, the line has passed. If the time is less then allowable, the line has failed.

b. The air pressure test should not be used when the pipe is submerged in groundwater, because the static water pressure will greatly affect the results. The water infiltration test will be used in this case.

c. For sections of pipe less than 36-inch average inside diameter, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be computed from the following equation:

$$T = 0.085(D)(K)/(Q)$$

where,

T = time for pressure to drop 1.0 pound per square inch gauge in seconds
K = 0.000419(D)(L), but not less than 1.0
D = average inside diameter in inches
L = length of line in feet of same pipe size being tested
Q = rate of loss, 0.0015 cubic feet per minute per square foot internal surface shall be used

d. Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as follows:

AIR TEST TABLE

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)
21	1190	114	10.471(L)
24	1360	100	13.676(L)
27	1530	88	17.309(L)
30	1700	80	21.369(L)
33	1870	72	25.856(L)

e. For sections of pipe with an average inside diameter less than thirty-six (36) inches, the test may be stopped if no pressure loss has occurred during the first twenty-five percent (25%) of the

calculated testing time. If any pressure loss has occurred during the first twenty-five percent (25%) of the testing period, then the test shall be continued for the entire required time.

f. Lines with an average inside diameter of twenty-seven (27) inches or larger may be air tested at each joint. Pipe with an inside diameter greater than thirty-six (36) inches shall be tested for leakage at each joint. A visual inspection of the line between the joints shall be performed immediately after an air test. Regardless of pipe size there shall be a minimum of ten (10) seconds allowable for the pressure to drop from 3.5 psig to 2.5 psig during a joint test.

D. Testing Manholes for Leakage. All manholes shall be tested for leakage separate from the collection system lines. Manholes may be tested for leakage via hydrostatic exfiltration testing or vacuum testing.

1. Hydrostatic Exfiltration Testing. All collection lines shall be plugged and the manhole filled with water. If leakage exceeds 0.025 gallons per foot of diameter per foot of head per hour, repairs shall be made to reduce leakage, and retests shall be performed until the leakage is below 0.025 gallons per foot of diameter per foot of head per hour. Concrete manholes may be filled for 24 hours prior to testing to allow for saturation of the concrete. For all manholes within nine (9) feet of a potable water line, the manhole shall be water tight and tested to have no leakage using the Hydrostatic Exfiltration Testing Method.
2. Vacuum Testing. All collection lines must be plugged and all lift holes and exterior joints plugged with a non-shrink grout. No grout may be placed in horizontal joints prior to testing. Tighten external clamps to secure test cover using a minimum 60 inch/lb. torque wrench. Place a test head inside top of cone section and inflate seal in accordance with manufacturers recommendations. Create a vacuum of 10 inches of mercury inside manhole. Test begins after vacuum pump is off. If vacuum drops below 9.0 inches of mercury after 2.0 minutes with all valves closed, the manhole fails and a retest must be performed.

E. Retests. Contractor shall test all sewer facilities and verify that they pass the specified test prior to requesting the Engineer or Owner to witness the tests. Sewer lines or manholes which fail to meet the requirements of the deflection or leak test will be tested again for leakage, after repairs have been completed by the Contractor. The sum of $50.00 per test, will be deducted from the amount due the Contractor to compensate the Owner for the costs of witnessing any failed tests.

END OF SECTION 33 31 13

SECTION 33 41 13 - STORM SEWERS AND APPURTENANCES

PART 1 - GENERAL

1.01 SUMMARY

A. This specification covers storm sewers, headwalls, inlets, culverts, culvert extensions, alterations of existing structures and miscellaneous items that are related to the drainage system.

1.02 RELATED SECTIONS

A. Section 31 23 33 - Excavation, Trenching, and Backfilling for Utilities

B. Section 31 50 00 - Excavation Safety

1.03 MEASUREMENT AND PAYMENT

A. Unless otherwise stated in the bid form, no separate payment will be made for work performed under this specification.

1.04 REFERENCES

A. The applicable provisions of the following standards shall apply as if written here in there entirely:
   1. AASHTO - American Association of State Highway and Transportation Officials
   2. ASTM - American Society of Testing and Materials
   3. TxDOT - Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges

1.05 SUBMITTALS

A. Submit manufacturer's certification that pipe meets the specified standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle pipe according to manufacturer's recommendations. Protect rubber gaskets from excessive heat and sunlight.

PART 2 - PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Corrugated Metal Pipe. Corrugated metal pipe shall be galvanized steel meeting AASHTO M218 or aluminized steel meeting AASHTO M274 with paved invert. Diameter shall be as shown on the Drawings. Minimum wall thickness shall be 16 gauge unless otherwise shown on Drawings. Coupling bands to have "O" ring rubber gaskets for watertight seal.

B. Reinforced Concrete Pipe. Unless otherwise shown on Drawings, use reinforced concrete pipe (RCP), ASTM C76, Class III, with rubber gasket joints.

C. High Density Corrugated Polyethylene Pipe (HDCPP).

1. Pipe and fitting material shall be high density polyethylene meeting ASTM D3350 minimum cell classification 324420C for 4-through 10-inch diameters or 335420C for 12-through 60-inch diameters.
2. Fittings shall conform to AASHTO M294. Fabricated fittings shall be welded on the interior and exterior at all junctions.
3. Pipe shall be joined with a bell-and-spigot type joint meeting the requirements of AASHTO M294. The joint shall be watertight according to the requirements of ASTM D3212. 30" through 60" pipe joints shall be watertight according to ASTM D3212 with the exception that the joint be tested using 5.0 psi (34.5 kPa) and the test apparatus shall meet the ASTM C1103 requirements. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477 with the condition that the gaskets shall not have any visible cracking when tested according to ASTM D1149 after 72-hour exposure in 50-PPHM ozone at 104° Fahrenheit. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to protect the gasket from debris. Joints shall remain watertight when subjected to a 1.5° axial misalignment. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

D. PVC Pipe. PVC pipe and fittings shall be manufactured from 12454B or 12454C all class material per ASTM D1784 and shall have a minimum stiffness in accordance with ASTM D2412. Joints may be external plastic sleeve with gaskets or an integral bell, gasketed joint. Joints shall be watertight in accordance with ASTM D3212.

E. Precast Concrete Box Culverts. Precast concrete boxes shall conform to ASTM C1433. Unless otherwise shown on Drawings, design for earth dead load plus HS20 live load.

F. Rubber Joint Gaskets. Gaskets for joints in bell and spigot concrete pipe shall meet ASTM C-443.

G. Materials for Drainage Structures: Mortar. The mortar used for other drainage structure connections shall consist of one (1) part by volume of Portland cement and two (2) parts of sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of AASHTO Specification M-45. Hydrated lime may be added to the sand and cement mixture in an amount of ten (10) percent of the volume of cement used. The hydrated lime shall comply with ASTM Specification C207, Type S requirements. The water quantity mixture shall be adequate to produce a stiff workable mortar, but shall not be greater than six (6) gallons of water per sack of cement. Water shall be clean and free of acids, alkalies, and organic impurities. The mortar shall be used within thirty (30) minutes from the time the ingredients are mixed with water. The mortar shall be protected on the outside in order to obtain a sufficient curing time.

2.02 SOURCE QUALITY CONTROL

A. Control cylinders of the reinforced concrete pipe (RCP) shall obtain a compressive strength of at least eighty (80) percent of the specified minimum strength before any concrete pipe can be delivered to the work site.

PART 3 - EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Laying pipe. The ends of the pipe shall be cleaned before the pipe is placed. The pipe shall be laid on a prepared foundation starting at the outlet end with the spigot ends pointed in the direction of the flow and shall continue toward the inlet end with the adjoining sections matched properly. The pipe shall be laid true to the lines and grades indicated on the Drawings. The mouth of the pipe shall be protected to prevent earth and bedding material from entering the pipe as each section is laid. The pipe shall be matched and fitted to form a smooth, uniform conduit when placed in the bed. The trench bottom shall be shaped and the excavation shall be performed as specified under applicable section No pipe shall be laid on unsuitable soft material, under any circumstances. Proper facilities are to be provided for hoisting and lowering the pipe sections into the trench without disturbing the prepared trench bottom or sides. The Contractor shall be responsible for dewatering of the trenches and the diversion of drainage during construction. Any pipe section that is laid and found to be defective or damaged shall be taken up and replaced or relaid at the cost of the Contractor.

B. Jointing. Assemble rubber gasket joints in accordance with recommendations of gasket manufacturers.

C. Inlets, headwalls, and other miscellaneous alterations and connections to existing drainage structures shall conform to the dimensions, locations and elevations and be constructed of the materials specified herein and shown on the Drawings.

D. Stub ends. Stubs for connection of future storm sewer pipe shall have watertight plugs installed in the end of the pipe such as a double course of brick or precast concrete plug.

3.02 REPAIR / RESTORATION

A. Any line in which opening or faulting of the joints occurs during backfilling or before the final inspection and acceptance, such that infiltration of materials or a change in flow characteristics results, shall be repaired or replaced by the Contractor.

END OF SECTION 33 41 13

SECTION 33 49 23 - STORM WATER DETENTION

- GENERAL

1.01 SECTION INCLUDES

A. Drainage & Storm Water:

1. Retention / Detention
   a. Box Culvert Systems
   b. Dry Wells
   c. Panel Vaults
   d. Storm Capture ®

B. Environmental
1. Containment
   a. Storage Tanks

1.02 REFERENCES

A. Where applicable, the latest editions of the following standards shall form a part of this specification to the extent referenced. The publications are referenced to in the text of this guide specification by the basic designation only.
1. American Association Of State Highway And Transportation Officials (AASHTO)
2. ACI International (ACI)
3. American National Standards Institute (ASTM)
4. Concrete Reinforcing Steel Institute (CRSI)
5. National Precast Concrete Association (NPCA)

1.03 GENERAL REQUIREMENTS

A. The completed retention/detention/infiltration structure shall not have lateral corridors that extend to the bottom of the modules except at the end of completed layout(s) if necessary. The structure to be used for storage/infiltration/detention shall be the Storm Capture® Module. The Seller of the precast retention/detention/infiltration structure shall also be the Manufacturer.

1.04 SUBMITTALS

A. The following items shall be submitted unless specified otherwise herein.

B. Design Data:

1. The precast concrete producer shall supply submittals showing design loading and material specifications for supplied products. At a minimum, the following shall be shown on the submittals:

a. Live load used in design.
b. Vertical and lateral earth loads used in design.
c. Depth of soil fill on the structure.
d. Water table depth used in calculations.

2. Upon request, the precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be sealed by a licensed professional engineer in the state of this project.

1.05 DESIGN

A. The following items shall be accounted for in the precast unit design.

B. Precast Concrete Unit Design

1. Design shall be done by a licensed professional engineer based on site conditions and anticipated loading.

C. Concrete Mix Design

1. Concrete mix design shall be done by a registered professional engineer.

1.06 QUALITY ASSURANCE

A. The precast concrete producer shall demonstrate adherence to the standards set forth in the plant Quality Control Manual.

B. Qualifications, Quality Control and Inspection

1. The precast producer shall maintain a permanent quality control department.
2. The precast concrete producer shall have a quality control program which is audited for compliance annually by persons outside that plant's employee structure.
3. Upon request, the precast concrete producer shall supply a copy of their quality control manual.

C. Quality Control

1. The precast concrete producer shall perform standard concrete testing and inspection.
   a. Concrete Testing
   b. Aggregate Testing
   c. Preplacement Check
      i. All products shall be inspected for accuracy prior to placing concrete.
   d. Postplacement Check
      i. All products shall be inspected for accuracy after the concrete forms have been removed.
   e. Copies of the test results and Inspections above shall be available upon request.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handling
   1. Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on the shop drawings. Upon request, the precast concrete producer shall provide documentation on acceptable handling methods for the product.

B. Storage
   1. Precast concrete units shall be stored in a manner that will minimize potential damage.

C. Delivery
   1. Precast concrete units shall be delivered to the site in accordance with the delivery schedule. Upon delivery to the jobsite, all precast concrete units shall be inspected by the customer's agent for quality and final acceptance.

D. Final Acceptance
   1. Upon final acceptance, the customer's agent acknowledges and understands the appropriate methods for handling the accepted precast concrete unit(s). Upon acceptance by the customer or customer's agent, the precast concrete manufacturer is not responsible for replacing damaged product resulting from improper handling practices on the job site.

1.08 PLANT CONDITIONS

A. Any plant producing precast concrete units for this specification shall have a written, implemented, comprehensive safety and environmental program.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer: Oldcastle Precast Inc., which has over 75 locations Nationwide
   Toll Free Tel: 888-9-OLDCASTLE (866-965-3227)
   Email: contact@oldcastleprecast.com
   Web: www.OldcastlePrecast.com

B. Substitutions: Not permitted without written approval from engineer of record prior to the bid date.

2.02 MATERIALS

A. Except as otherwise specified, material shall conform to the following section.

2.03 MANUFACTURE

A. Manufacture shall conform to the producer's acceptable quality control manual

B. Forms
   1. Forms for manufacturing precast concrete units shall be of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected cause no damage to the precast concrete unit.
   2. Forms shall be cleaned of concrete build-up after each use.
   3. Form release agents shall be applied according to the manufacturer's recommendations and shall not be allowed to build up on the form casting surface.

C. Reinforcement
   1. Cages of reinforcement shall be fabricated by tying the bars, wires or welded wire reinforcement. The tolerances for concrete cover shall be 3/8 in. or as specified in the design. Welding shall be allowed only for ASTM A 706 rebar.
      a. Positive means shall be taken so that the reinforcement does not move significantly during the casting operations

D. Embedded Items

   1. Embedded items shall be positioned at locations specified in the design documents. Inserts and other embeds shall be held rigidly in place so that they do not move significantly during casting operations.

E. Concrete
   1. Patching and Repair
      a. Repairing Minor Defects
         i. Defects that will not impair the functional use or expected life of the precast concrete unit may be repaired by any method that does not impair the product.
      b. Repairing Honeycombed Areas
         i. When honeycombed areas are to be repaired, all loose material shall be removed and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. Otherwise, the area shall be saturated with water. Immediately prior to repair, the area should be damp, but free of excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material

into the cavity.

c. Repairing Major Defects
   i. Defects in precast concrete products which impair the functional use or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

2. Shipping Precast Concrete Units
   a. Precast concrete units shall not be shipped until they have reached at least 70% of their specified 28-day design strength, unless damage will not result, impairing the performance of the product.

PART 3 - EXECUTION

3.01 SURVEY

A. The installation area shall be surveyed using the work print and a checklist to identify the work to be done and to determine that the Drawings are correct.

B. All underground facilities and structures such as gas, water, sewer, power, telephone cable, and so forth shall be located and identified. Location markings shall be placed by the affected utilities before construction.

C. The survey shall identify and obstacles such as overhead wires, building structures that will interfere with crane operations, work progress, or create a safety hazard.

D. The survey shall give consideration to the soil structure so that proper shoring, sloping, or both may be planned in advance of the excavation work

3.02 PLANNING

A. Permits required to do work in accordance with the detail plans shall be secured before starting the job. All permits or a record of the permits shall be retained on the job for immediate reference

B. All utilities and owners of surface and subsurface facilities and structures in the area shall be given advance notification of proposed excavation. Every effort shall be made to avoid damage to the facilities of others. If any damage occurs, the owner of the damaged facility shall be notified immediately.

C. Planning shall include the coordination of all responsible parties so that arrangements for removal of excess and damaged material have been made.

D. Should it appear that a structure location will interfere with traffic, review the situation with the engineer and notify appropriate authorities.

E. Provide for access to call boxes, fire hydrants, etc.

3.03 SAFETY REQUIREMENTS

A. Safety requirements for construction shall be in accordance with all federal, state, and local regulations.

3.04 EXCAVATING

A. If unforeseen facilities or obstructions are encountered, stop excavation operations immediately. Expose the obstruction with wood handled digging tools and investigate them with caution. If there is any doubt as to the type of obstruction exposed, request positive identification from those suspected of owning the facility and then proceed as circumstances dictate.

B. Inspect excavations after every rainstorm or other hazard-increasing occurrence, and increase the protection against slides and cave-ins, if necessary.

C. In dewatering excavations, make certain that the discharge is carried to a suitable runoff point. Also verify that the design accounts for the level of groundwater encountered.

D. Excavation size shall be large enough to allow access around the structure after it is installed.

3.05 SHORING

A. Shoring for construction shall be in accordance with all federal, state, and local regulations.

3.06 INSTALLATION

A. Site Access: The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage, and proper handling of the precast concrete units.

B. Subgrade Bedding Materials and compaction: The installation contractor shall be responsible for ensuring that the subgrade is compacted to 95% of ASTM D558 density. The subgrade shall be a minimum of 6” in depth. A granular material shall be used to create a level surface for placing the precast concrete unit.

C. Installation:

1. Precast concrete units shall be installed: to the lines and grades shown on the

contract documents or otherwise specified; be lifted by suitable lifting devices at points provided by the precast concrete producer; in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions.

2. Field modifications to the product shall relieve the precast producer of liability and warranty regardless if such modifications result in the failure of the precast concrete unit.

3.07 BACKFILLING AND RESTORATION

A. Do the backfilling as soon as possible after the structure has been placed.

B. Backfill material shall be granular and free from large stones, rocks, and pavement. Expansive soil material shall not be used as backfill around the structure.

C. Backfilling shall be achieved by lifts (layers) to the required compaction.

D. Follow up inspections for settlements are required. Should settlement occur, the contractor shall be responsible for all necessary repairs.

3.08 FIELD QUALITY CONTROL

A. Inspection

1. Final field elevations and compaction properties shall be verified and documented.

END OF SECTION 33 49 23