

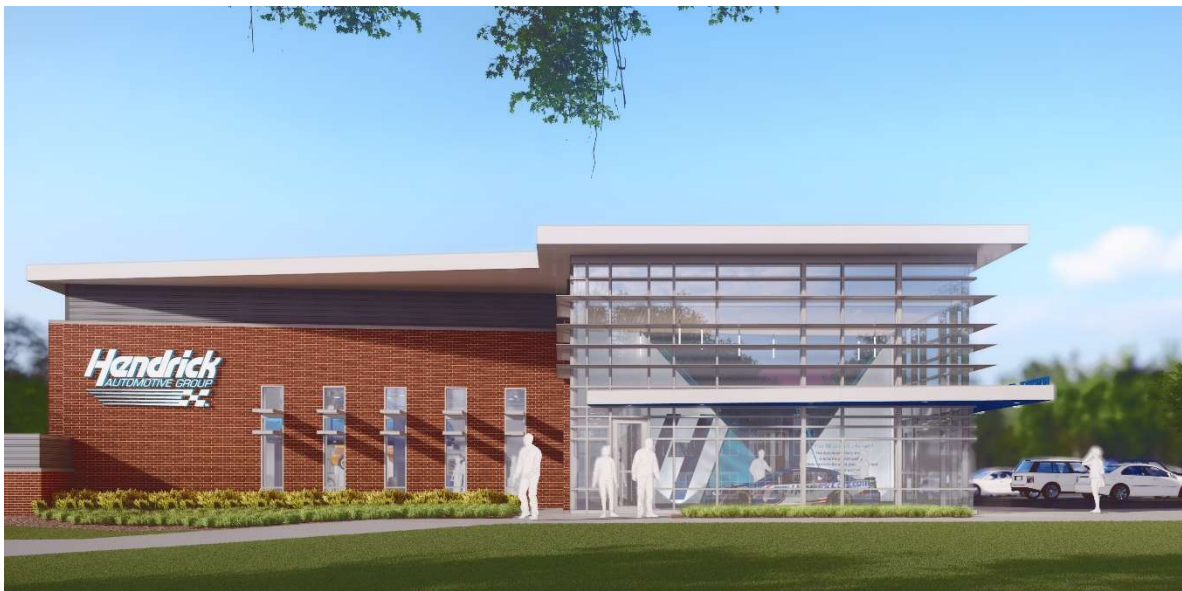
Project Manual



— SINCE 1964 —
RICHMOND
COMMUNITY COLLEGE

Richmond Community College Hendrick Center for Automotive Training

1042 West Hamlet Avenue
Hamlet, NC 28345



Bid Documents

March 3, 2025

Project Number #23014

SCO #22-25472-01A

adwarchitects
environmentsforlife

architecture

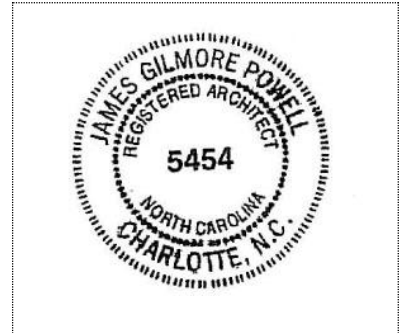
planning

interiors

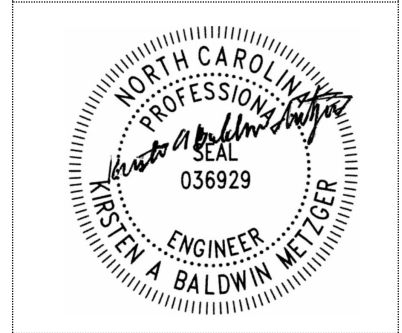
SECTION 00 01 11 – PROFESSIONAL SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

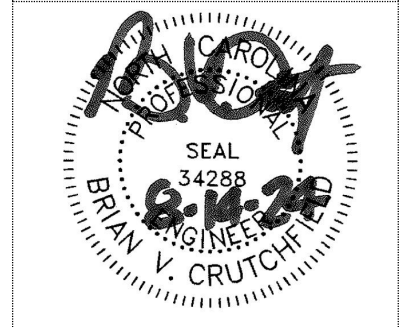
ARCHITECT James G. Powell, AIA



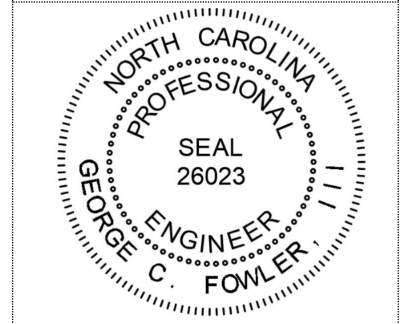
STRUCTURAL ENGINEER Kirsten Baldwin Metzger, PE



CIVIL ENGINEER Brian V. Crutchfield, PE



PLUMBING ENGINEER George C. Fowler III, PE



MECHANICAL
ENGINEER

Ronald V. Almond, PE



ELECTRICAL
ENGINEER

Brandon L. Miller, PE



END OF DOCUMENT

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END OF SECTION 00 01 10

ADVERTISEMENT FOR BIDS
Richmond Community College – Hendrick Center for Automotive Training

Sealed proposals for Base Bid will be received until **1:00 pm Tuesday, April 8, 2025** in the Grimsley Health Science Building Room #102 at Richmond Community College to the Attention of Brent Barbee, Richmond Community College -1042 W Hamlet Ave Hamlet, NC 28345 & **1:00 pm** bid opening in the Grimsley Health Science Building Room #102, for the construction of the Hendrick Center for Automotive Training at which time and place bids will be opened and read.

Bidding Documents may be viewed and ordered online by registering with Duncan Parnell via their bid room <https://bidroom.duncan-parnell.com/>. Registration with Duncan Parnell is required to obtain the bid documents and be added to the official Plan Holder's List. Addenda notification will be sent to those buying full sets from Duncan Parnell via their bid room. The cost of bid documents and shipping is non-refundable. Neither OWNER nor ENGINEER will be responsible for copies of the bid documents obtained from sources other than from Duncan Parnell. If you need any assistance ordering or getting registered on <https://bidroom.duncan-parnell.com/> please contact: Michaela Bruinius at constech@duncan-parnell.com or 704-526-1856.

Drawings may be viewed at ConstructConnect, Inc., www.constructconnect.com (and sister companies Construction Market Data (CMD), iSqFt, Reed, Smartbid, Bidclerk) and the Blue Book Building and Construction Network, www.thebluebook.com

An open, non-mandatory pre-bid conference will be held at Richmond Community College in the Grimsley Health Science Building Room #102 on **Thursday, March 13, 2025 at 2:00 PM**. The preferred alternates will be identified at the pre-bid conference. In accordance with GS133-3 and SCO procedures the following preferred brand items are being considered as Alternates by the Owner for this project:

Preferred Alternates:

Alternate No. 1 - Provide Schlage Everest keying system. See Specification Section 08 71 00.

Alternate No. 2 - Provide BACnet DDC system from Alerton. See Specification 23 09 00 Direct Digital Control System.

Alternate No. 3- Provide modified bitumen roofing, as manufactured by SOPREMA. See Specification 07 51 00.

Alternates:

Alternate No. 4 - Masonry/Metal screen wall in lieu of fixed louver screen. See Sheet A900.

The state reserves the unqualified right to reject any and all proposals.

Signed: Brent Barbee, MPA
President
Richmond Community College
1042 W. Hamlet Ave
Hamlet, NC 28345

NOTICE TO BIDDERS

Sealed proposals for Base Bid will be received until **1:00 pm Tuesday, April 8, 2025** in the Grimsley Health Science Building Room #102 at Richmond Community College to the Attention of Brent Barbee, Richmond Community College -1042 W Hamlet Ave Hamlet, NC 28345 & 1:00 pm bid opening in the Grimsley Health Science Building Room #102, for the construction of the Hendrick Center for Automotive Training- at which time and place bids will be opened and read.

Pre-Bid Meeting

An open, non-mandatory pre-bid conference will be held at Richmond Community College in the Grimsley Health Science Building Room #102 on **Thursday, March 13, 2025 at 2:00 PM**. The preferred alternates will be identified at the pre-bid conference. In accordance with GS133-3 and SCO procedures the following preferred brand items are being considered as Alternates by the Owner for this project:

The meeting is also to identify preferred brand alternates and their performance standards that the owner will consider for approval on this project. In accordance with General Statute GS 133-3, Specifications may list one or more preferred brands as an alternate to the base bid in limited circumstances. Specifications containing a preferred brand alternate under this section must identify the performance standards that support the preference. Performance standards for the preference must be approved in advance by the owner in an open meeting. Any alternate approved by the owner shall be approved only where (i) the preferred alternate will provide cost savings, maintain or improve the functioning of any process or system affected by the preferred item or items, or both, and (ii) a justification identifying these criteria is made available in writing to the public.

In accordance with GS133-3 and SCO procedures the following preferred brand items are being considered as Alternates by the owner for this project:

Preferred Alternates:

Alternate No. 1 - Provide Schlage Everest keying system. See Specification Section 08 71 00.

Alternate No. 2 - Provide BACnet DDC system from Alerton. See Specification 23 09 00 Direct Digital Control System.

Alternate No. 3 - Provide modified bitumen roofing, as manufactured by SOPREMA. See Specification 07 51 00.

Alternate

No. 4 - Masonry/Metal screen wall in lieu of fixed louver screen. See Sheet A900.

Justification of any approvals will be made available to the public in writing no later than seven (7) days prior to bid date.

Bidding Documents may be viewed and ordered online by registering with Duncan Parnell via their bid room <https://bidroom.duncan-parnell.com/>. Registration with Duncan Parnell is required to obtain the bid documents and be added to the official Plan Holder's List. Addenda notification will be sent to those buying full sets from Duncan Parnell via their bid room. The cost of bid documents and shipping is non-refundable. Neither OWNER nor ENGINEER will be responsible for copies of the bid documents obtained from sources other than from Duncan

Parnell. If you need any assistance ordering or getting registered on <https://bidroom.duncan-pannell.com/> please contact: Michaela Bruinius at constech@duncan-pannell.com or 704-526-1856.

Drawings may be viewed at ConstructConnect, Inc., www.constructconnect.com (and sister companies Construction Market Data (CMD), iSqFt, Reed, Smartbid, Bidclerk) and the Blue Book Building and Construction Network, www.thebluebook.com

NOTE: The bidder shall include with the bid proposal the form *Identification of Minority Business Participation* identifying the minority business participation it will use on the project and shall include either *Affidavit A* or *Affidavit B* as applicable. Forms and instructions are included within the Proposal Form in the bid documents. Failure to complete these forms is grounds for rejection of the bid. (GS143-128.2c Effective 1/1/2002.)

All contractors are hereby notified that they must have proper license as required under the state laws governing their respective trades.

General contractors are notified that Chapter 87, Article 1, General Statutes of North Carolina, will be observed in receiving and awarding general contracts. General contractors submitting bids on this project must have license classification for **Building Contractor**.

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company, insured by the Federal Deposit Insurance Corporation, of an amount equal to not less than five percent (5%) of the proposal, or in lieu thereof a bidder may offer a bid bond of five percent (5%) of the bid executed by a surety company licensed under the laws of North Carolina to execute the contract in accordance with the bid bond. Said deposit shall be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten days after the award or to give satisfactory surety as required by law.

A performance bond and a payment bond will be required for one hundred percent (100%) of the contract price.

Payment will be made based on ninety-five percent (95%) of monthly estimates and final payment made upon completion and acceptance of work.

No bid may be withdrawn after the scheduled closing time for the receipt of bids for a period of 60 days.

The owner reserves the right to reject any or all bids and to waive informalities.

Designer:

Phillip Steele
Senior Principal, Project Manager
ADW Architects, PA
2815 Coliseum Centre Drive. Suite 500
Charlotte, NC 28217
Phone #: 704-379-1919

Owner:

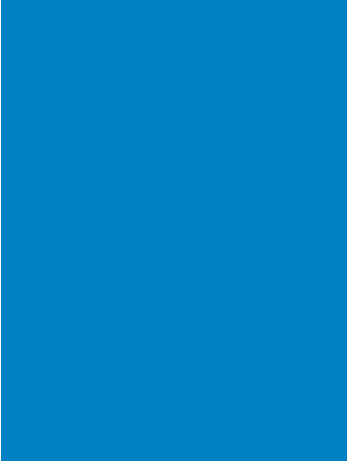
Brent Barbee, MPA
President
Richmond Community College
1042 W Hamlet Ave
Hamlet, NC 28345
Phone #: 910-410-1809

SECTION 00 31 32A - GEOTECHNICAL DATA

The following geotechnical information was compiled by:

*ECS Southeast, LLP
6151 Raeford Road, Suite A
Fayetteville, NC 28304*

The enclosed soil report is meant only as an aid to the Contractor during the bidding and construction phases and do not guarantee the soil conditions at the project site. Unit price for unsuitable soil is required of the Contractor on the Bid Form to cover actual conditions above and beyond what is noted in the attached Geotechnical report. The contractor SHALL include in their base bid the cost of ALL recommendations listed in the attached report.



ECS Southeast, LLP

Geotechnical Engineering Report

Hendrick Auto Tech Building

1042 Hamlet Avenue
Hamlet, North Carolina

ECS Project No. 33:6568

October 4, 2023





ECS SOUTHEAST, LLP

"One Firm. One Mission."

Geotechnical • Construction Materials • Environmental • Facilities

October 4, 2023

Mr. Brent Barbee, MPA
Richmond Community College
Post Office Box 1189
Hamlet, North Carolina 28345

ECS Project No. 33:6568

Reference: Geotechnical Engineering Report
Hendrick Auto Tech Building
1042 Hamlet Avenue
Hamlet, Richmond County, North Carolina

Dear Mr. Barbee:

ECS Southeast, LLP (ECS) has completed the subsurface exploration, laboratory testing, and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our agreed to scope of work. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted, and our design and construction recommendations.

It has been our pleasure to be of service to Richmond Community College during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations as well to verify subsurface conditions assumed for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southeast, LLP

Caitlin M. Cerza
Geotechnical Project Manager
CCerza@ecslimited.com

DocuSigned by:



DocuSigned by:

804EC847FB8B4AC...
Barnabas Bwambale, Ph.D., P.E.
Associate Principal Engineer
BBwambale@ecslimited.com

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EXECUTIVE SUMMARY

This executive summary is intended as a very brief overview of the primary geotechnical conditions that are expected to affect design and construction. Information gleaned from the executive summary should not be utilized in lieu of reading the entire geotechnical report.

- Structural loading for the proposed construction was not available at the time this report was prepared. However, based on the assumed framing and anticipated construction material type, we estimate maximum column and wall loads will be less than 100 kips and 2 kips per linear foot, respectively.
- Relatively loose soils were encountered in Boring B-04 between the approximate of 3 to 8 feet below existing grades. Depending on the final design foundation subgrade elevations and size of footings, isolated undercutting of footings might be necessary in areas represented by this boring.
- Provided the subgrades are prepared as recommended in this report, the planned building may be supported by conventional shallow foundations consisting of column or strip footings bearing on compacted structural fill and natural soils sized using a net allowable soil bearing pressure of 2,500 psf.
- Based on the N-values measured in the borings, a Seismic Site Class **D** is recommended for seismic design of the proposed structures. Geophysical testing to measure shear wave velocities of the subsurface materials could be performed for this project to potentially improve the site class.
- ECS should be retained to review the design documents for conformance with our recommendations.
- ECS should be retained for construction materials testing and special inspections to facilitate proper implementation of our recommendations.

1.0 INTRODUCTION

The purpose of this study was to provide geotechnical information for the design of foundations and pavements for the proposed building. The project will include the construction of a new automotive technology building and its associated pavements. The recommendations developed for this report are based on project information supplied by Mr. Brent Barbee, MPA of Richmond Community College.

Our services were provided in accordance with our Proposal No. 33:5888R1-GP dated August 14, 2023, as authorized by Mr. Brent Barbee on August 14, 2023, which includes our Terms and Conditions of Service.

This report contains the procedures and results of our subsurface exploration and laboratory testing programs, review of existing site conditions, engineering analyses, and recommendations for the design and construction of the project.

The report includes the following items.

- Observations from our site reconnaissance including current site conditions.
- Brief review of the published geologic conditions.
- Description of the field exploration and laboratory tests performed.
- Characterization of the subsurface conditions.
- Recommended allowable soil bearing pressure for conventional shallow foundations.
- Recommendations for slab-on-grade design and construction.
- Recommendations for seismic site classification.
- Recommendations for design and construction of the pavements.
- Evaluation of the on-site soil characteristics encountered at the testing locations, including reuse of on-site soil as engineered fill, compaction requirements and structural fill material guidelines.
- Site and boring location diagrams.
- Logs of the soil borings and results of the laboratory testing.

2.0 PROJECT INFORMATION

2.1 SITE INFORMATION

The subject site is located at 1042 Hamlet Avenue in Hamlet, North Carolina on the existing Richmond Community College campus. The proposed building addition will be constructed on the western edge of the parking lot located north of Grimsley Building and south of the outdoor amphitheater area. The location of the site is shown on Figure 2.1.1 and indicated on the Site Location Diagram in Appendix A.

The property is currently developed with an existing paved parking lot and landscaped lawn area. There is overhead electric running along the southwest boundary of the property. Based on our review of the provided grading and drainage plan (Sheet C-3 dated August 4, 2006), the existing ground surface in the proposed building area is relatively flat with elevations of approximately 291 to 295 feet, NAVD88.



Figure 2.1.1. Site Location

2.2 PROPOSED CONSTRUCTION

The following information explains our understanding of the planned building:

SUBJECT	DESIGN INFORMATION / ASSUMPTIONS
Building Footprint	Approximately 15,000 square feet
# of Stories	One story, high-bay
Usage	Classroom, office, and automotive lab
Column Loads	100 kips maximum (assumed)
Wall Loads	2 kips per linear foot maximum (assumed)
Ground Floor Slab Load	150 pounds per square foot maximum (assumed)
Lowest Finish Floor Elevation	±2 feet from existing grades

The structural engineer should verify these assumptions and notify ECS if the actual unfactored foundation design loads exceed or are significantly less than these assumed values.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

Our exploration procedures are explained in greater detail in Appendix B including the insert titled Subsurface Exploration Procedures. Our scope of work included drilling 5 borings. Our borings were located with a handheld GPS unit and their approximate locations are shown on the Boring Location Diagram in Appendix A.

3.2 LABORATORY TESTING

Each sample was visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). The laboratory testing consisted of selected tests performed on samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples in accordance with ASTM D2487 Standard Practice for Classification for Engineering Purposes (Unified Soil Classification System (USCS)). Classification and index property tests performed included two moisture content tests, two percent passing sieve number 200 (wash sieve) tests, and two Atterberg limits tests.

After identification and classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses along with the soil descriptions. The stratification lines between strata on the logs are approximate; in situ, the transitions may be gradual.

3.3 SUBSURFACE CHARACTERIZATION

The site is located within the Coastal Plain physiographic province. The Coastal Plain is typically characterized by marine, alluvial, and aeolian sediments that were deposited during periods of fluctuating sea levels and moving shorelines. Basal formations are typical of those laid down in a shallow sloping sea bottom; dense sand, consolidated clay, limestone, chalk, marl, claystone, and sandstone. Overburden soils include marine interbedded gravel, sand, silt, and clay. Many of the clays have been preconsolidated by desiccation from frequent rising and lowering of the sea level and groundwater table. Alluvial gravel, sand, silt, and clay are typically present near rivers and creeks.

The generalized subsurface conditions encountered in the borings are described below. The depths given in the following table are average depths. The actual strata depths may vary significantly at specific boring locations. For soil stratification at a particular test location, the respective boring log found in Appendix B should be reviewed.

Approximate Depth (ft.)	Stratum	Description	Ranges of SPT ⁽¹⁾ N-values (bpf)
0 to 0.5	N/A	Surficial Material: Topsoil (3 to 4 inches) and Asphalt (2 to 3 inches) underlain with ABC stone (0 to 3 inches)	N/A
0.5 to 9	I	Coastal Plain: Very Loose to Medium Dense SAND (SM, SC)	2 to 24
9 to 40	II	Coastal Plain: Stiff to Very Hard SANDY LEAN CLAY (CL) with interbedded Medium Dense to Very Dense SAND (SM, SC)	12 to 50+

Notes:

- (1) Standard Penetration Testing

A graphical presentation of the subsurface conditions is shown on the Subsurface Cross Section Diagram included in Appendix A. Please note that the ground surface elevations shown on the boring logs and cross section were not surveyed by a licensed surveyor. These elevations were interpolated using topographic information obtained from the civil drawing provided to us and they should be considered approximate.

3.4 GROUNDWATER OBSERVATIONS

Water levels were measured in our borings as noted on the boring logs in Appendix B. Groundwater depths measured at the time of drilling ranged from 2 to 8 feet below the ground surface. Variations in the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors.

4.0 DESIGN RECOMMENDATIONS

4.1 FOUNDATIONS

Provided subgrades and structural fills are prepared as recommended in this report, the proposed structure can be supported by shallow foundations including column footings and continuous wall footings. We recommend the foundation design use the following parameters:

Design Parameter	Column Footing	Wall Footing
Net Allowable Bearing Pressure ⁽¹⁾	2,500 psf	2,500 psf
Acceptable Bearing Soil Material	Stable Natural Soil or Compacted Structural Fill	
Minimum Width	30 inches	18 inches
Minimum Footing Embedment Depth (below slab or finished grade) ⁽²⁾	12 inches	12 inches
Estimated Total Settlement ⁽³⁾	Less than 1 inch	Less than 1 inch
Estimated Differential Settlement ⁽⁴⁾	Less than ½ inch between columns	Less than ½ inch over 50 feet

Notes:

- (1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
- (2) For bearing considerations and frost penetration requirements.
- (3) Based on assumed structural loads. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.
- (4) Based on maximum column/wall loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are more complete.

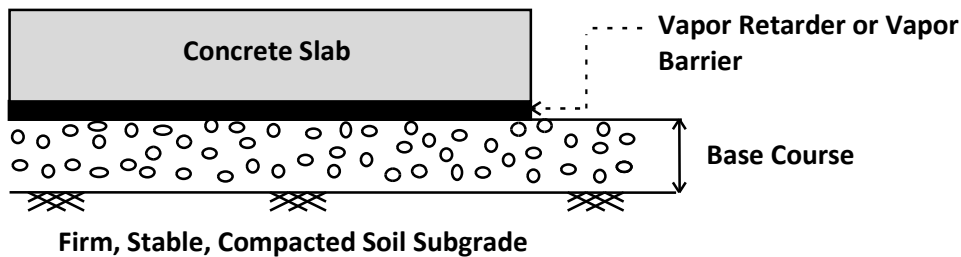
Potential Undercuts: *Relatively loose soils were encountered in Boring B-04 between the approximate of 3 to 8 feet below existing grades. Depending on the final design foundation subgrade elevations and size of footings, isolated undercutting of footings might be necessary in areas represented by this boring.* If soft or loose soils are observed at the footing bearing elevations, the soils should be undercut and removed. Undercut should be backfilled with structural fill up to the original design bottom of footing elevation; the original footing may be constructed on top of the structural fill.

4.2 SLABS ON GRADE

Assuming the finished floor elevation is around the current site elevations, it appears that the slabs for the structure will bear on the near-surface Stratum I soils and/or new compacted structural fill. These materials can support a slab-on-grade; however, there may be areas of soft or yielding soils that should be removed and replaced with compacted structural fill in accordance with the recommendations included in this report.

We assume that the ground floor slabs-on-grade will be at or above finish exterior grades around the entire building footprints. For this case, the 2018 North Carolina Building Code does not require damproofing or waterproofing of the slab. However, depending on floor coverings and building use, a capillary break layer and vapor retarder should be installed to prevent excessive moisture from coming in contact with the concrete floor slab from the soils below.

The following graphic depicts our soil-supported slab recommendations:



4.2.1 Floor Slab Section

1. Base Course Layer Thickness: 4 inches, minimum
2. Base Course Layer Material: A compactable granular fill that will remain unyielding and support construction traffic. At least 10% to 30% of the material should pass a No. 100 sieve with a maximum aggregate size of ¾ inch. Satisfactory materials are GRAVEL (ABC, GW, GW-SM), SAND (SP-SM, SW-SM), and SILTY SAND (SM) with less than 30% fines.
3. Base Course Layer Material should be compacted to at least 98% maximum dry density per ASTM D698.
4. Undisturbed natural subgrade should proofroll as firm and unyielding. Upper 1 foot of structural fill subgrade should be compacted to at least **98%** maximum dry density per ASTM D698
5. Vapor Barrier or Vapor Retarder – Refer to ACI 302.1R-04 Guide for Concrete Floor and Slab Construction and ASTM E 1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs for recommendations on this issue. Additionally, any environmental vapor intrusions considerations should be taken into account by the vapor barrier/vapor retarder material selection and design.

Subgrade Modulus: Provided a base course break layer is implemented in the slab section, the slabs may be designed using a modulus of subgrade reaction of 150 psi/in. This value is applicable for design of slabs subject to point loads and should be reduced based on loaded area for uniform sustained distributed loads.

Slab Isolation: Soil-supported slabs should be isolated from the foundations and foundation-supported elements of the structure so that differential movement between the foundations and slab will not induce excessive shear and bending stresses in the floor slab. Where the structural configuration does not allow the use of a free-floating slab such as in a drop down footing/monolithic slab configuration, the slab should be designed with suitable reinforcement and load transfer devices to preclude overstressing of the slab.

4.3 SEISMIC DESIGN CONSIDERATIONS

Seismic Site Classification: The 2018 North Carolina Building Code (2015 International Building Code with North Carolina Amendments) requires that a Site Class be assigned for the seismic design of new structures based on the upper 100 feet of a soil profile. At least two methods are utilized in classifying sites, namely the shear wave velocity (v_s) method and the Standard Penetration Resistance (N-value) method. The N-value method was used for this project.

SEISMIC SITE CLASSIFICATION			
Site Class	Soil Profile Name	Shear Wave Velocity, Vs (ft./s)	N value (bpf)
A	Hard Rock	$V_s > 5,000$	N/A
B	Rock	$2,500 < V_s \leq 5,000$	N/A
C	Very dense soil and soft rock	$1,200 < V_s \leq 2,500$	>50
D	Stiff Soil Profile	$600 \leq V_s \leq 1,200$	15 to 50
E	Soft Soil Profile	$V_s < 600$	<15

Based upon our interpretation of the subsurface conditions, the appropriate Seismic Site Classification is "D" as shown in the preceding table. The Site Class definition should not be confused with the Seismic Design Category designation which the Structural Engineer typically assesses.

Our experience indicates that evaluation of seismic site class in North Carolina using N-values can be overly conservative. If it is determined that significant advantage could be gained with an improved Site Class, additional site testing could be performed to measure actual shear wave velocities at the site. ECS can provide a proposal for these services upon request.

4.4 PAVEMENTS

Design Traffic Loading: Detailed traffic loading information for the project is not available. We have assumed a design traffic loading of up to 10,000 ESALs in 20 years for light duty pavements and up to 50,000 ESALs in 20 years, for heavy duty pavements.

Subgrade Characteristics: Based on the results of our borings, it appears that the soils that will be exposed as pavement subgrades consist mainly of Silty SAND (SM), Clayey SAND (SC), or approved structural fill. California Bearing Ratio (CBR) testing was not performed as part of this study. For section thickness design purposes, we estimate a CBR value of 6 based on local experience. The pavement design assumes subgrades consist of unyielding materials evaluated by ECS and placed and compacted to at least 98 percent of the maximum dry density as determined by the standard Proctor test (ASTM D 698) in accordance with the project specifications.

Minimum Material Thicknesses: Pavements for the project are expected to consist of light duty parking areas and heavy duty pavements in truck traffic areas. We recommend the following minimum pavement sections for the project.

PROPOSED PAVEMENT SECTIONS			
MATERIAL	FLEXIBLE PAVEMENT		RIGID PAVEMENT
	Light Duty	Heavy Duty	
Portland Cement Concrete ($f'_c = 4000$ psi, air-entrained)	-	-	5 inches
Asphalt Surface Course (S9.5B)	2 inches	3 inches	-
Aggregate Base Course (ABC)	6 inches	6 inches	4 inches

In general, heavy duty sections are areas that will be subjected to trucks, buses, or other similar vehicles including main drive lanes of the development. Light duty sections are appropriate for vehicular traffic and parking areas.

ECS should be allowed to review these recommendations and make appropriate revisions based upon the formulation of the final traffic design criteria for the project. It is important to note that the design sections do not account for construction traffic loading.

It should also be noted that these design recommendations may not satisfy the North Carolina Department of Transportation traffic guidelines. Any roadways constructed for public use and to be dedicated to the State for repair and maintenance must be designed in accordance with the State requirements.

Concrete Pavements: Large, front loading garbage trucks frequently impose concentrated front wheel loads on pavements during loading of trash dumpsters. This type of loading typically results in rutting of bituminous pavements and ultimately pavement failures and costly repairs. Therefore, we suggest that the pavements in trash pickup areas utilize the Portland Cement Concrete (PCC) pavement section. It may be prudent to use rigid pavement sections in all areas planned for heavy truck traffic.

The Portland cement concrete pavement section should consist of air-entrained Portland cement concrete having a minimum 28-day compressive strength of 4,000 psi. The rigid pavement section should be provided with construction joints and saw-cut control joints at appropriate intervals per Portland Cement Association (PCA) requirements. The construction joints should be reinforced with dowels to transfer loads across the joints. Wire mesh should be included to control shrinkage cracking of the concrete.

We used a Load Transfer Coefficient, J , of 4.2 to determine the recommended concrete pavement thickness given in the preceding table. The concrete pavement section thickness is for plain jointed concrete pavement with reinforcement dowels only at construction joints.

Drainage: An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the aggregate base course layer, softening of the subgrades and other problems related to the deterioration of the pavement can be expected. This is particularly important at the site due to the moisture sensitive near-surface soils. Furthermore, good drainage should help reduce the possibility of the subgrade materials becoming saturated during the normal service period of the pavement.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 SUBGRADE PREPARATION

5.1.1 Previous Site Development

When reviewing our recommendations, please note that there are existing pavements on this site, and that previous grading activities have occurred on this site. Our experience with previously graded sites indicates that unexpected conditions can exist that were not encountered by the soil test borings. Unexpected conditions could include areas of soft or loose fill, debris-laden fill, and other obstructions or conditions. These conditions should be addressed by on-site engineering evaluation by ECS during construction.

5.1.2 Site Demolition

Site demolition should include the removal of existing asphalt, concrete slabs, concrete curb and gutter, underground utilities, underground stormwater structures and pipes, and buried structures from the proposed construction areas. Any underground utilities that may exist within the proposed building areas should be relocated, and any within proposed pavement areas should be evaluated by the design team and relocated or filled with grout, if necessary. Excavations or cavities resulting from demolition should be backfilled with compacted structural backfill.

The existing asphalt at the site could be re-used as new aggregate base course (ABC) in private low-traffic volume pavement areas such as parking lots, provided it meets the NCDOT standard specifications for ABC gradation or Class II Fine Aggregate. It is ECS' understanding that the reuse of demolished asphalt pavements as structural fill is not expressly forbidden by state environmental regulations. However, because asphalt is a petroleum-based product, the potential exists for leaching of petroleum into the surrounding soil matrix and possibly into groundwater. Therefore, ECS recommends the demolished asphalt pavements that cannot be incorporated as new aggregate base course (ABC) as stated above should be transported to an approved off-site disposal location or asphalt plant for possible recycling.

5.1.3 Stripping and Grubbing

The subgrade preparation should consist of stripping vegetation, rootmat, topsoil, existing fill, and any soft or unsuitable materials from the 10-foot expanded building and 5-foot expanded pavement limits, and 5 feet beyond the toe of structural fills. The borings encountered approximately 3 to 4 inches of topsoil. ECS should be retained to document that topsoil and unsuitable surficial materials have been removed prior to the placement of structural fill or construction of structures.

5.1.4 Proofrolling

Prior to fill placement or other construction on subgrades, the subgrades should be evaluated by an ECS field technician. The exposed subgrade should be thoroughly proofrolled with construction equipment having a minimum axle load of 10 tons [e.g., fully loaded tandem-axle dump truck]. Proofrolling should be traversed in two perpendicular directions with overlapping passes of the vehicle under the observation of an ECS technician. This procedure is intended to assist in identifying any localized yielding materials.

Where proofrolling identifies areas that are yielding or “pumping” subgrade, those areas should be repaired prior to the placement of any subsequent structural fill or other construction materials. Methods of stabilization include undercutting, moisture conditioning, or chemical stabilization. The situation should be discussed with ECS to determine the appropriate procedure. Test pits may be excavated to explore the shallow subsurface materials to help in determining the cause of the observed unstable materials, and to assist in the evaluation of appropriate remedial actions to stabilize the subgrade.

5.2 EARTHWORK OPERATIONS

5.2.1 Excavation Considerations

Excavation Safety: All excavations and slopes should be made and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing and constructing stable, temporary excavations and slopes and should shore, slope, or bench the sides of the excavations and slopes as required to maintain stability of both the excavation sides and bottom. The contractor’s responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor’s safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor’s activities; such responsibility is not being implied and should not be inferred.

Construction Dewatering: Based on the borings, our experience with groundwater fluctuations on similar sites, and assumed design grades, most of the temporary excavations are unlikely to encounter groundwater. However, some of the stormwater and utility excavations will likely encounter groundwater. The contractor should be prepared to remove any precipitation or groundwater that may seep into temporary construction excavations using open pumping. Open pumping utilizes submersible sump pumps in pits or trenches dug below the bottom of the excavation and backfilled with No. 57 stone.

5.2.2 Structural Fill

Prior to placement of structural fill, representative bulk samples (about 50 pounds) of on-site and/or off-site borrow should be submitted to ECS for laboratory testing, which will typically include Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships (i.e., Proctors) for compaction. Import materials should be tested prior to being hauled to the site to determine if they meet project specifications. Alternatively, Proctor data from other accredited laboratories can be submitted if the test results are within the last 90 days.

Structural Fill Materials: Materials for use as structural fill should consist of inorganic soils with the following engineering properties and compaction requirements.

STRUCTURAL FILL INDEX PROPERTIES	
Subject	Property
Building and Pavement Areas	LL < 40, PI < 20
Max. Particle Size	3 inches
Max. Organic Content	2% by dry weight

STRUCTURAL FILL COMPACTION REQUIREMENTS	
Subject	Requirement
Compaction Standard	Standard Proctor, ASTM D698
Required Compaction	98% of Max. Dry Density within top 12 inches, and 95% elsewhere
Moisture Content	-3 to +3% points of the soil's optimum value
Loose Thickness	8 inches prior to compaction

On-Site Borrow Materials: The on-site soils meeting the classifications for recommended structural fill, plus meeting the restrictions on organic content and debris, may be reused as structural fill. We anticipate that some soils encountered in the borings within the anticipated excavation depths can be used as compacted structural fill. On-site soils used as structural fill will require careful moisture control to achieve compaction and stability.

Depending on weather conditions at the time of construction, moisture conditioning of the on-site soils may be difficult. As such, the potential need for importing drier materials should be considered in project planning.

Fill Placement: Fill materials should not be placed on frozen soils, on frost-heaved soils, and/or on excessively wet soils. Borrow fill materials should not contain frozen materials at the time of placement, and all frozen or frost-heaved soils should be removed prior to placement of structural fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned.

5.3 FOUNDATION AND SLAB OBSERVATIONS

Protection of Foundation Excavations: Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 1 to 3-inch thick "mud mat" of "lean" concrete should be placed on the bearing soils before the placement of reinforcing steel.

Footing Subgrade Observations: Most of the soils at the foundation bearing elevation are anticipated to be suitable for support of the proposed structure. It is important to have ECS observe the foundation subgrade prior to placing foundation concrete, to confirm the bearing soils are what was anticipated.

Slab Subgrade Observation: A representative of ECS should be called on to observe exposed subgrades within the expanded building limits prior to structural fill placement to assure that adequate subgrade preparation has been achieved. Proofrolling using a drum roller or loaded dump truck should be performed in their presence at that time. Once subgrades have been determined to be firm and unyielding, structural fill can be placed.

If there will be a significant time lag between the site grading work and final grading of concrete slab areas prior to the placement of the design floor slab section materials, a representative of ECS should be called on to observe the condition of the prepared soil subgrade. Prior to final floor slab section construction, the soil subgrade may require scarification, moisture conditioning, and re-compaction to restore stable conditions.

5.4 PAVEMENTS

Subgrade Evaluation: The soil subgrade should be smooth-rolled and proofrolled prior to ABC placement. Areas that pump, rut, or are otherwise yielding should be re-compacted or undercut and replaced. The amount of undercutting will be dependent on design grades and weather conditions at the time of construction.

Aggregate Base Course: The ABC should conform with the gradation, liquid limit, plasticity index, resistance to abrasion, and soundness per Section 1005 of the 2012 NCDOT Standard Specifications for Roads and Structures.

The ABC should be placed and be compacted in accordance with Section 520 of the 2012 NCDOT Standard Specifications for Roads and Structures. The ABC should be placed in a single lift. It should be spread after end-dumping on previously-placed ABC to prevent rutting and degradation of the relatively clean sand subgrade soils by rubber-tired dump trucks. The ABC should be compacted to at least 98 percent of its modified Proctor maximum dry unit weight per ASTM D1557 or AASHTO T180 (as modified by NCDOT), provided nuclear density testing is performed. Otherwise, at least 100 percent compaction is recommended.

To document that the specified degree of compaction is being obtained, field compaction testing should be performed in each ABC lift by the geotechnical engineer's representative. We recommend that compaction tests be performed at a minimum frequency of one test per 5,000 square feet per lift in pavement areas.

The early placement of the ABC will minimize the deterioration of the prepared soil subgrades. However, some loss of graded aggregate due to rutting and surface contamination may occur prior to final asphalt or concrete paving. Some infilling and re-grading of the aggregate base course may be required. The ABC should be smooth-rolled and proofrolled prior to asphalt or concrete pavement placement. Areas that pump, rut, or are otherwise yielding should be wetted or dried as needed and re-compacted. Alternatively, yielding areas could be undercut and replaced.

Minimum Material Lift Thickness: The minimum lift thickness for asphalt surface course mix S9.5B is 1.0 inch and the maximum lift thickness for S9.5B is 1.5 inches. For sections with more than 1.5 inches of S9.5B surface asphalt, it should be placed in two lifts. Asphalt pavement S9.5B should be compacted to least 90.0 percent of the material's specific gravity G_{mm} .

Asphalt Quality Control/Quality Assurance: We recommend that the asphalt contractor perform quality control procedures and testing per the project specifications to establish the required roller pattern(s). Quality assurance testing should be provided by ECS and should consist of coring the placed asphalt pavement to check thickness and compaction.

6.0 CLOSING

ECS has prepared this report to guide the geotechnical-related design and construction aspects of the project. We performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation, expressed or implied, and no warranty or guarantee is included or intended in this report.

The description of the proposed project is based on information provided to ECS by Mr. Brent Barbee of Richmond Community College. If any of this information is inaccurate or changes, either because of our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted so we can review our recommendations and provide additional or alternate recommendations that reflect the proposed construction.

We recommend that ECS review the project plans and specifications so we can confirm that those plans/specifications are in accordance with the recommendations of this geotechnical report.

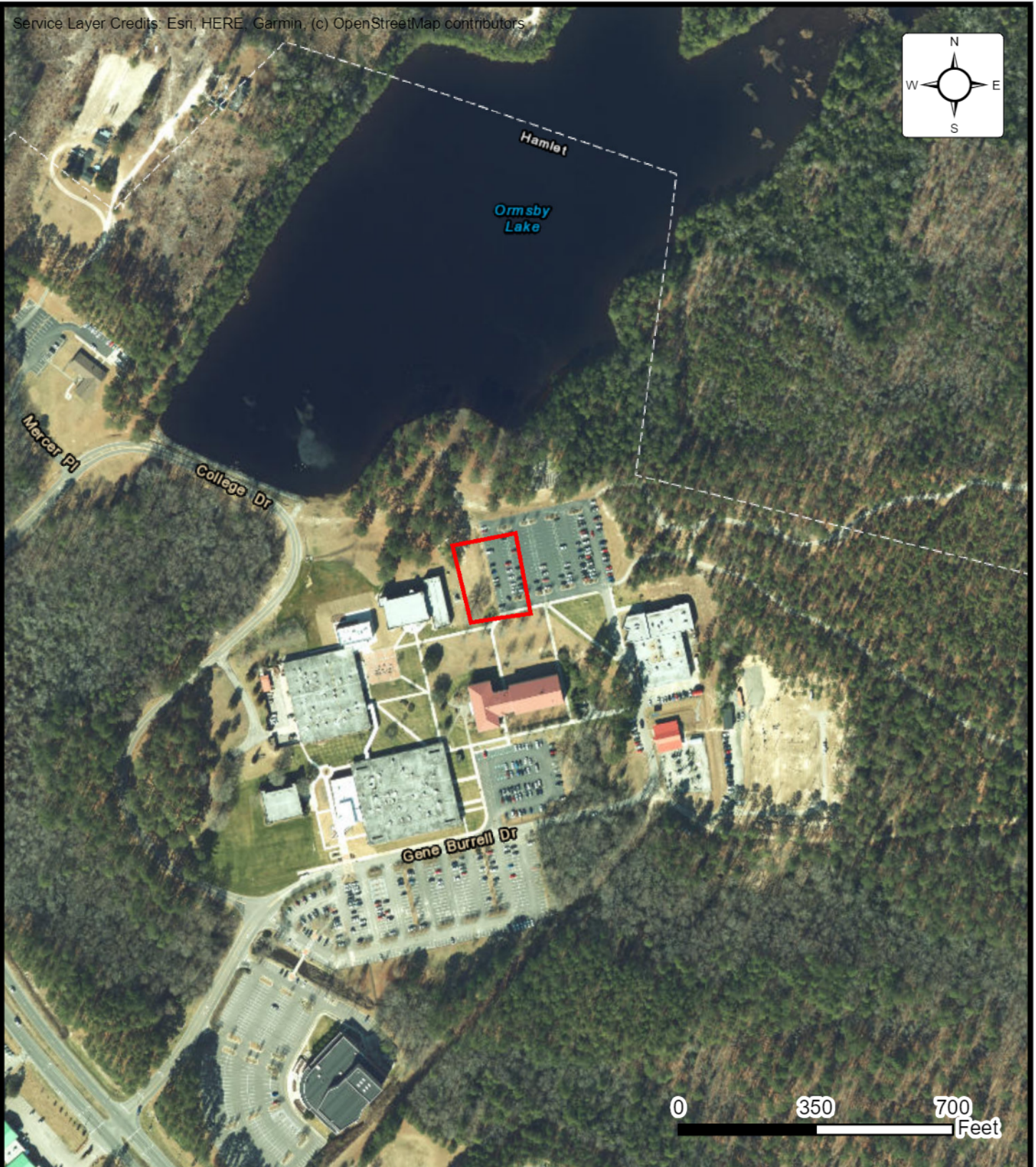
Field observations, and quality assurance testing during earthwork and foundation installation are an extension of, and integral to, the geotechnical design. We recommend that ECS be retained to apply our expertise throughout the geotechnical phases of construction, and to provide consultation and recommendation should issues arise.

ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

APPENDIX A – Diagrams & Reports

Site Location Diagram
Boring Location Diagram
Subsurface Cross Section

Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors



SITE LOCATION DIAGRAM HENDRICK AUTO TECH BUILDING

1042 HAMLET AVE, HAMLET, NC
RICHMOND COMMUNITY COLLEGE

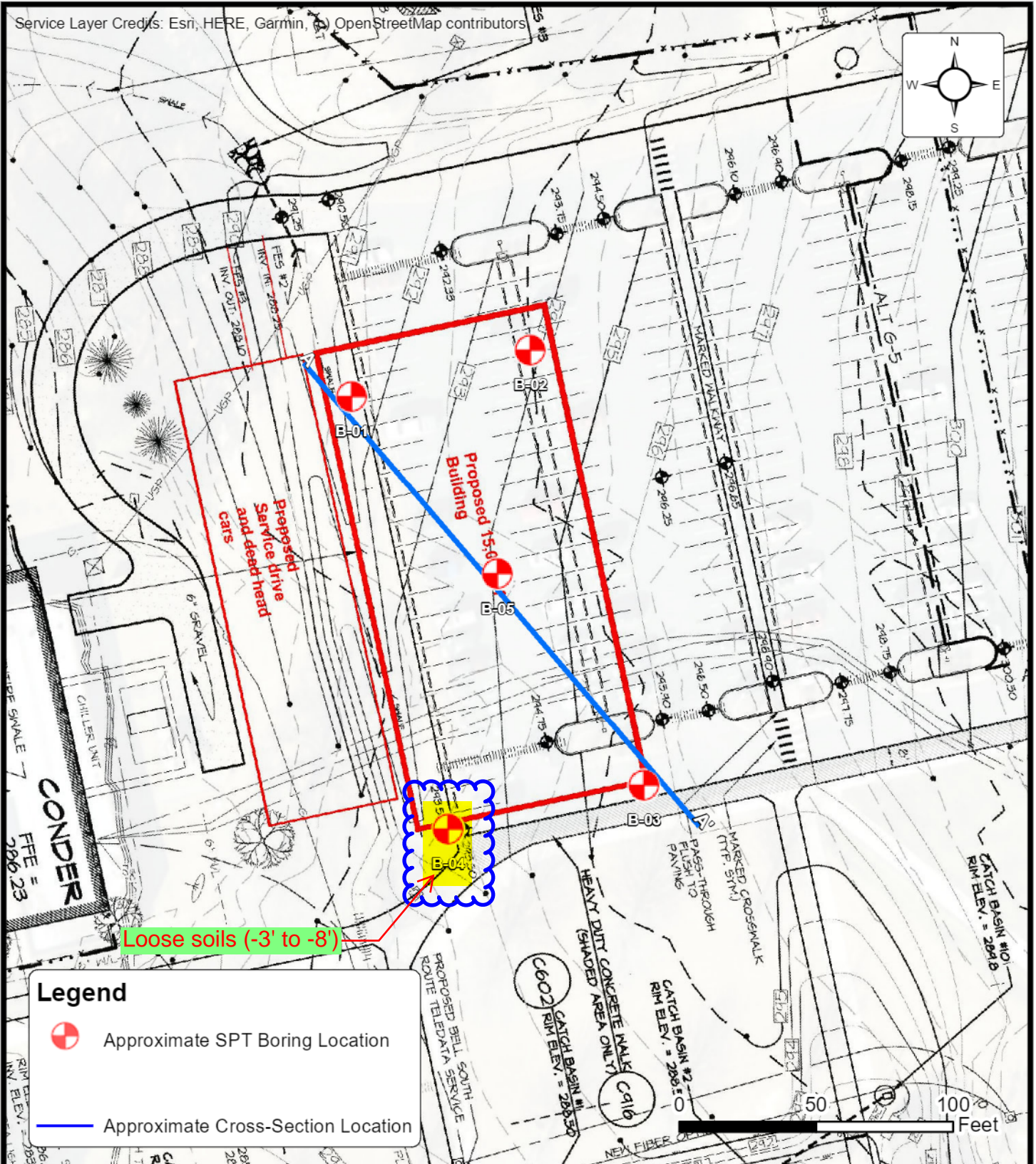
ENGINEER
BB

SCALE
AS NOTED

PROJECT NO.
33:6568

FIGURE
1 OF 2

DATE
9/28/2023

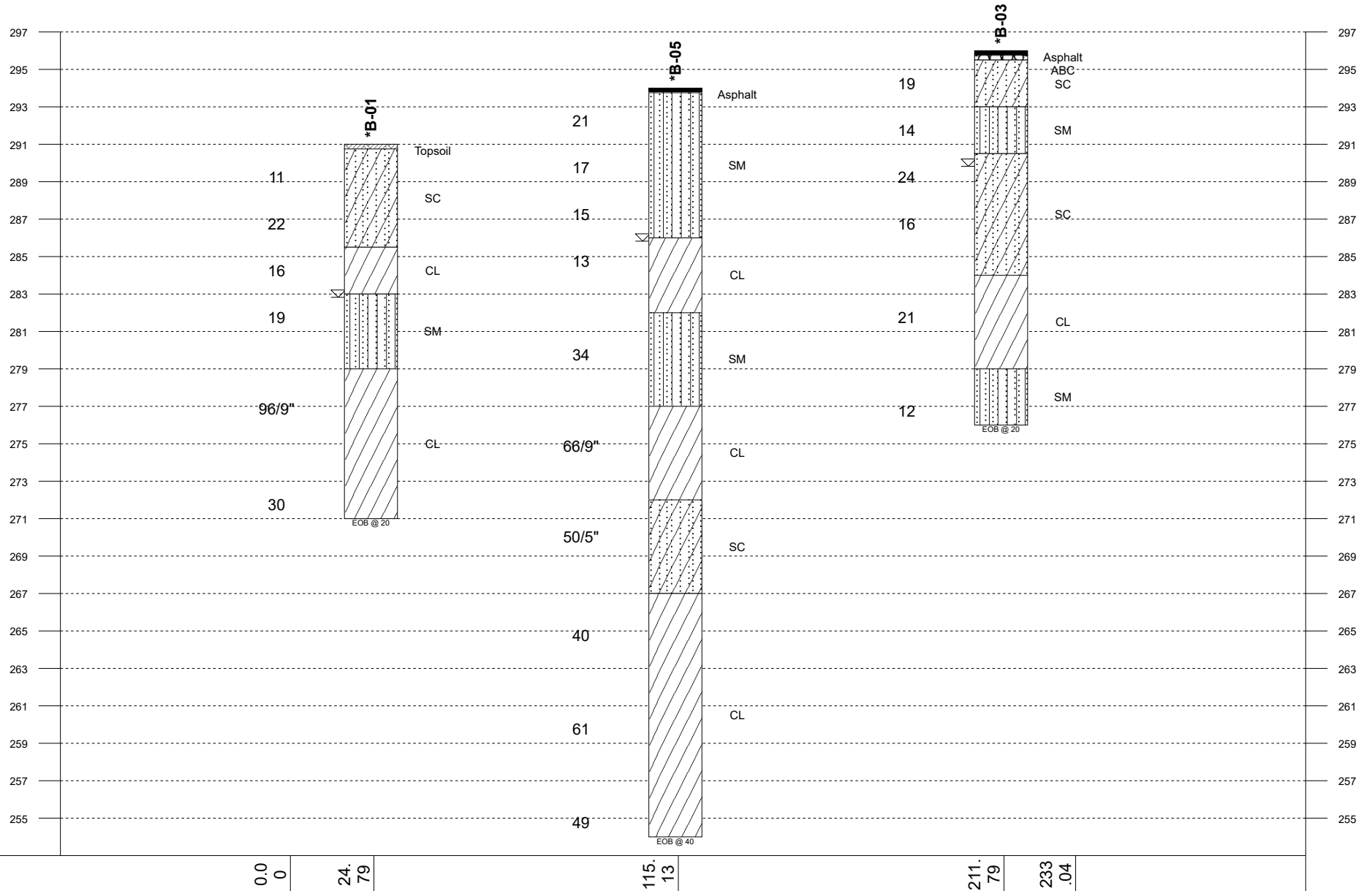


BORING LOCATION DIAGRAM HENDRICK AUTO TECH BUILDING

1042 HAMLET AVE, HAMLET, NC

RICHMOND COMMUNITY COLLEGE

ENGINEER BB
SCALE AS NOTED
PROJECT NO. 33:6568
FIGURE 2 OF 2
DATE 9/29/2023



- Legend Key**
- Asphalt
 - ABC
 - SC
 - SM
 - Topsoil
 - CL

253.00

Notes:
 1- EOB: END OF BORING AR: AUGER REFUSAL SR: SAMPLER REFUSAL.
 2- THE NUMBER BELOW THE STRIPS IS THE DISTANCE ALONG THE BASELINE.
 3- SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL INFORMATION.
 4- STANDARD PENETRATION TEST RESISTANCE (LEFT OF BORING) IN BLOWS PER FOOT (ASTM D1586).

Plastic Limit X	Water Content ●	Liquid Limit △	▽ WL (First Encountered)	■ Fill
[FINES CONTENT %]			▽ WL (Completion)	■ Possible Fill
▼ BOTTOM OF CASING			▽ WL (Estimated Seasonal High Water)	■ Probable Fill
100% LOSS OF CIRCULATION			▽ WL (Stabilized)	■ Rock



GENERALIZED SUBSURFACE SOIL PROFILE A-A'

Hendrick Auto Tech Building
Richmond Community College
1042 Hamlet Ave, Hamlet, North Carolina, 28345

Project No: 33.6568 Date: 10/04/2023

APPENDIX B – Field Operations

Reference Notes for Boring Logs

Subsurface Exploration Procedure: Standard Penetration Test (SPT)

Boring Logs B-01 through B-05



REFERENCE NOTES FOR BORING LOGS

MATERIAL ^{1,2}	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	GW WELL-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GP POORLY-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GM SILTY GRAVEL gravel-sand-silt mixtures
	GC CLAYEY GRAVEL gravel-sand-clay mixtures
	SW WELL-GRADED SAND gravelly sand, little or no fines
	SP POORLY-GRADED SAND gravelly sand, little or no fines
	SM SILTY SAND sand-silt mixtures
	SC CLAYEY SAND sand-clay mixtures
	ML SILT non-plastic to medium plasticity
	MH ELASTIC SILT high plasticity
	CL LEAN CLAY low to medium plasticity
	CH FAT CLAY high plasticity
	OL ORGANIC SILT or CLAY non-plastic to low plasticity
	OH ORGANIC SILT or CLAY high plasticity
	PT PEAT highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION		
DESIGNATION	PARTICLE SIZES	
Boulders	12 inches (300 mm) or larger	
Cobbles	3 inches to 12 inches (75 mm to 300 mm)	
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")	<0.074 mm (smaller than a No. 200 sieve)	

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, QP ⁴	SPT ⁵ (BPF)	CONSISTENCY ⁷ (COHESIVE)
<0.25	<2	Very Soft
0.25 - <0.50	2 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

RELATIVE AMOUNT ⁷	COARSE GRAINED (%) ⁸	FINE GRAINED (%) ⁸
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective (ex: "Silty")	25 - 45	30 - 45

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT ⁵	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

WATER LEVELS ⁶	
	WL (First Encountered)
	WL (Completion)
	WL (Seasonal High Water)
	WL (Stabilized)

FILL AND ROCK			
FILL	POSSIBLE FILL	PROBABLE FILL	ROCK

¹Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

²To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

³Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-FILL)].

⁴Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

⁵Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.

⁶The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

⁷Minor deviation from ASTM D 2488-17 Note 14.

⁸Percentages are estimated to the nearest 5% per ASTM D 2488-17.



SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TEST (SPT) - ASTM D 1586 Split-Barrel Sampling


The Standard Penetration Test (SPT) is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The SPT N-value (or blow counts), when corrected and correlated, can be used to approximate the engineering properties of soils for geotechnical design and engineering purposes.

SPT Procedure:

- Involves driving a 2-inch outer diameter split-barrel (split-spoon) sampler into the soil by dropping a 140-lb hammer a height of 30 inches at the desired test depth.
- Recording the number of hammer blows required to drive the split-spoon sampler a distance of 18 to 24 inches (in 3 or 4 increments of 6 inches each).
- The SPT N-value (blows per foot) is determined by summing the blow counts for the 2nd and 3rd six-inch intervals.
- The boring is advanced* to the desired depths and additional SPTs are performed.
- SPT tests are typically performed at 2½-foot intervals within the upper 10 feet of the boring and 5-foot intervals thereafter.
- Soil samples are obtained at each test depth for visual classification and laboratory testing.
- The drill rig is equipped with either an automatic hammer or a rope and cathead driving assembly. The automatic hammer generally delivers more energy to the sampler than the standard cathead assembly.
- Although the differences in energy will vary, it is common to assume the automatic hammer delivers about 1.3 times the energy of the cathead assembly.
- The uncorrected N-values recorded in the field are typically reported on the soil test boring logs.



*Drilling methods may vary, but the predominant drilling methods used for SPT are the open hole fluid rotary (mud rotary) drilling and hollow-stem auger drilling.

CLIENT: Richmond Community College	PROJECT NO.: 33:6568	BORING NO.: B-01	SHEET: 1 of 1	
PROJECT NAME: Hendrick Auto Tech Building	DRILLER/CONTRACTOR: Mid Atlantic Drilling, Inc.			


SITE LOCATION: 1042 Hamlet Ave, Hamlet, North Carolina, 28345			LOSS OF CIRCULATION 
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: 291
			BOTTOM OF CASING 

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT / PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %		
									20	40	60	80	100	1	2	3	4	5	10
					Topsoil Thickness[3.00"]														
5	S-1	SS	18	18	(SC) CLAYEY FINE TO MEDIUM SAND, orange, moist, medium dense		286	4-4-7 (11)	11										
	S-2	SS	18	18				7-9-13 (22)	22										
	S-3	SS	18	18	(CL) SANDY LEAN CLAY, tan/orange, moist, very stiff			3-6-10 (16)	16										
10	S-4	SS	18	18	(SM) SILTY FINE TO MEDIUM SAND, pink/ white, wet, medium dense		281	3-6-13 (19)	19										
	S-5	SS	15	15	(CL) SANDY LEAN CLAY, gray to tan, wet, very hard to very stiff			17-46-50/3" (96/9")	96/9"										
15							276												
20	S-6	SS	18	18				15-15-15 (30)	30										
					END OF BORING AT 20 FT		271												
25							266												
30							261												

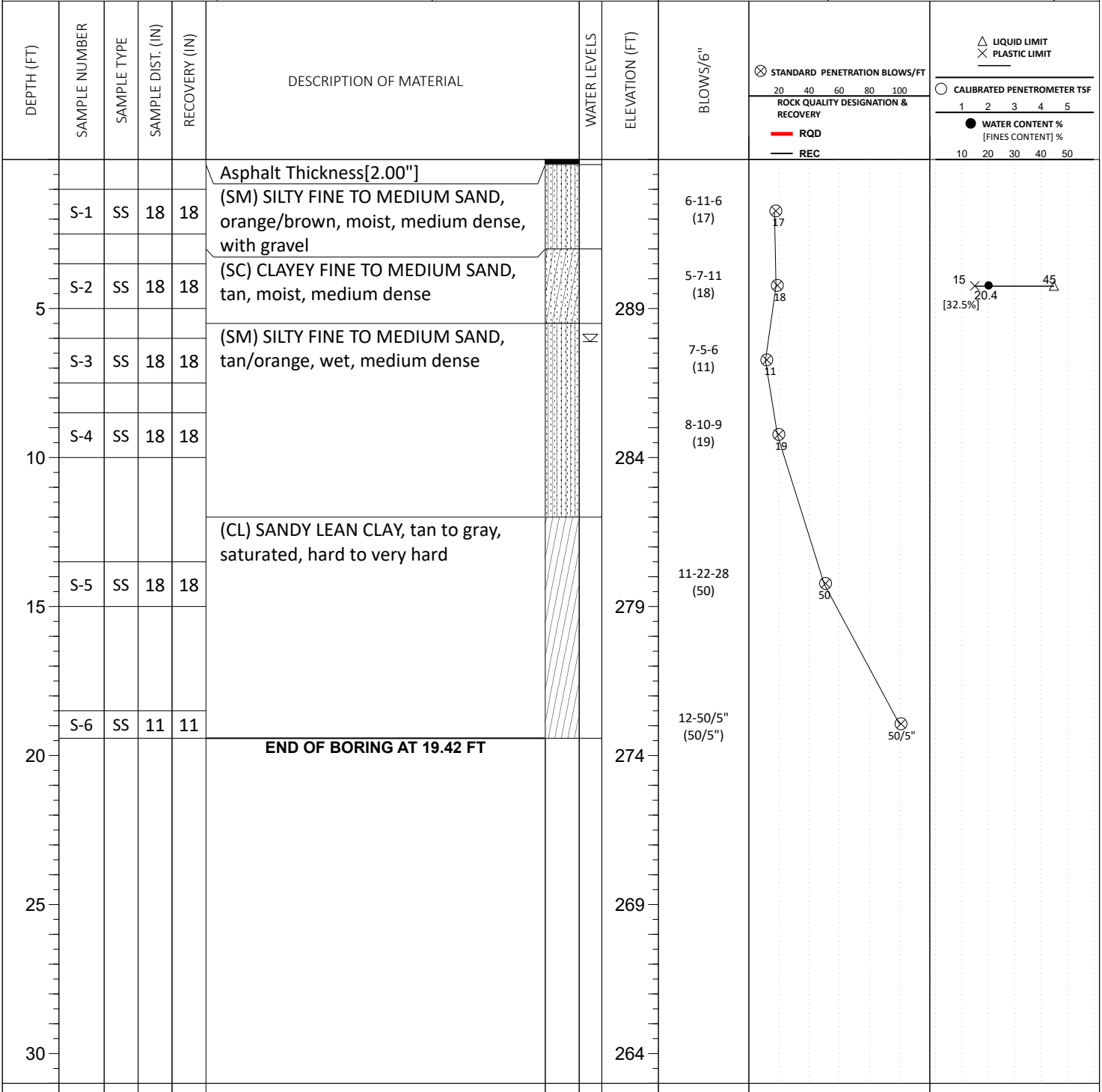
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

▽ WL (First Encountered)	8.00	BORING STARTED:	Aug 28 2023	CAVE IN DEPTH:
▼ WL (Completion)		BORING COMPLETED:	Aug 28 2023	HAMMER TYPE: Auto
▽ WL (Seasonal High Water)		EQUIPMENT:	Track	LOGGED BY:
▽ WL (Stabilized)			OMA	DRILLING METHOD: Mud rotary

GEOTECHNICAL BOREHOLE LOG

CLIENT: Richmond Community College	PROJECT NO.: 33:6568	BORING NO.: B-02	SHEET: 1 of 1	
PROJECT NAME: Hendrick Auto Tech Building	DRILLER/CONTRACTOR: Mid Atlantic Drilling, Inc.			

SITE LOCATION: 1042 Hamlet Ave, Hamlet, North Carolina, 28345			LOSS OF CIRCULATION 
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: 294
			BOTTOM OF CASING 



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

∇ WL (First Encountered)	6.00	BORING STARTED:	Aug 28 2023	CAVE IN DEPTH:
▼ WL (Completion)		BORING COMPLETED:	Aug 28 2023	HAMMER TYPE: Auto
∇ WL (Seasonal High Water)		EQUIPMENT:	Track	LOGGED BY:
∇ WL (Stabilized)			OMA	DRILLING METHOD: Mud rotary

GEOTECHNICAL BOREHOLE LOG

CLIENT: Richmond Community College	PROJECT NO.: 33:6568	BORING NO.: B-03	SHEET: 1 of 1	
PROJECT NAME: Hendrick Auto Tech Building	DRILLER/CONTRACTOR: Mid Atlantic Drilling, Inc.			

SITE LOCATION: 1042 Hamlet Ave, Hamlet, North Carolina, 28345			LOSS OF CIRCULATION
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NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: 296	BOTTOM OF CASING
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DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		CALIBRATED PENETROMETER TSF	
									20	40	60	80
					Asphalt Thickness[3.00"] ABC Stone Thickness[3.00"]							
5	S-1	SS	18	18	(SC) CLAYEY FINE TO MEDIUM SAND, orange/brown, moist, medium dense, with gravel		291	11-8-11 (19)	19			
	S-2	SS	18	18	(SM) SILTY FINE TO MEDIUM SAND, brown, moist, medium dense			4-5-9 (14)	14			
	S-3	SS	18	18	(SC) CLAYEY FINE TO MEDIUM SAND, brown, moist to wet, medium dense			6-9-15 (24)	24			
10	S-4	SS	18	18			286	6-8-8 (16)	16			
					(CL) SANDY LEAN CLAY, tan, wet, very stiff							
15	S-5	SS	18	18			281	6-12-9 (21)	21			
					(SM) SILTY FINE SAND, pink/white, wet, medium dense, with clay lenses							
20	S-6	SS	18	18			276	5-3-9 (12)	12			
					END OF BORING AT 20 FT							
25							271					
30							266					

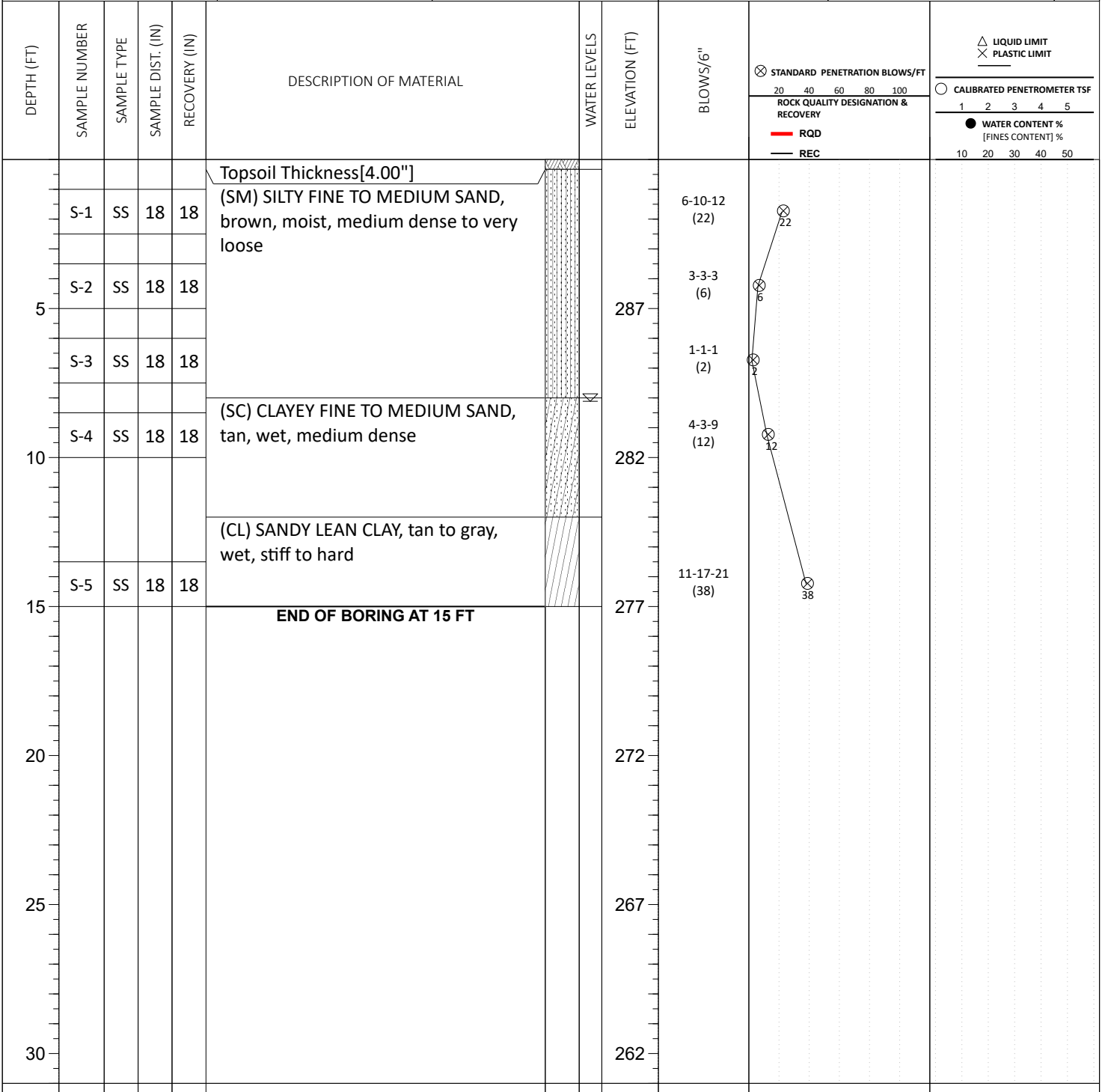
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

∇ WL (First Encountered)	6.00	BORING STARTED:	Aug 28 2023	CAVE IN DEPTH:
▼ WL (Completion)		BORING COMPLETED:	Aug 28 2023	HAMMER TYPE: Auto
∇ WL (Seasonal High Water)		EQUIPMENT:	Track	LOGGED BY:
∇ WL (Stabilized)			OMA	DRILLING METHOD: Mud rotary

GEOTECHNICAL BOREHOLE LOG

CLIENT: Richmond Community College	PROJECT NO.: 33:6568	BORING NO.: B-04	SHEET: 1 of 1	
PROJECT NAME: Hendrick Auto Tech Building	DRILLER/CONTRACTOR: Mid Atlantic Drilling, Inc.			


SITE LOCATION: 1042 Hamlet Ave, Hamlet, North Carolina, 28345			LOSS OF CIRCULATION 
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: 292
			BOTTOM OF CASING 



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

∇ WL (First Encountered) 8.00	BORING STARTED: Aug 28 2023	CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: Aug 28 2023	HAMMER TYPE: Auto
∇ WL (Seasonal High Water)	EQUIPMENT: Track	LOGGED BY: OMA
∇ WL (Stabilized)		DRILLING METHOD: Mud rotary

GEOTECHNICAL BOREHOLE LOG

CLIENT: Richmond Community College	PROJECT NO.: 33:6568	BORING NO.: B-05	SHEET: 1 of 2	
PROJECT NAME: Hendrick Auto Tech Building	DRILLER/CONTRACTOR: Mid Atlantic Drilling, Inc.			

SITE LOCATION: 1042 Hamlet Ave, Hamlet, North Carolina, 28345			LOSS OF CIRCULATION 
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: 294
			BOTTOM OF CASING 

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
									⊗ STANDARD PENETRATION BLOWS/FT	— RQD	— REC	○ WATER CONTENT % [FINES CONTENT] %
					Asphalt Thickness[3.00"]							
5	S-1	SS	18	18	(SM) SILTY FINE TO MEDIUM SAND, brown/orange, moist, medium dense		289	12-11-10 (21)	⊗ 21			
	S-2	SS	18	18				6-7-10 (17)	⊗ 17			
	S-3	SS	18	18				9-9-6 (15)	⊗ 15			
10	S-4	SS	18	18	(CL) SANDY LEAN CLAY, tan, wet, stiff		284	3-4-9 (13)	⊗ 13			
					(SM) SILTY FINE TO MEDIUM SAND, tan/ orange, wet, dense, with clay lenses			11-21-13 (34)	⊗ 34			
15	S-5	SS	18	18			279					
					(CL) SANDY LEAN CLAY, gray, wet, very hard			4-16-50/3" (66/9")	⊗ 66/9"			
20	S-6	SS	15	15			274					
					(SC) CLAYEY FINE SAND, gray, wet, very dense			38-50/5" (50/5")	⊗ 50/5"			
25	S-7	SS	11	11			269					
					(CL) SANDY LEAN CLAY, gray, wet, hard to very hard			11-17-23 (40)	⊗ 40			
30	S-8	SS	18	18			264					

CONTINUED ON NEXT PAGE

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

▽ WL (First Encountered)	8.00	BORING STARTED:	Aug 28 2023	CAVE IN DEPTH:
▼ WL (Completion)		BORING COMPLETED:	Aug 28 2023	HAMMER TYPE: Auto
▽ WL (Seasonal High Water)		EQUIPMENT:	Track	LOGGED BY:
▽ WL (Stabilized)			OMA	DRILLING METHOD: Mud rotary

GEOTECHNICAL BOREHOLE LOG

CLIENT: Richmond Community College	PROJECT NO.: 33:6568	BORING NO.: B-05	SHEET: 2 of 2	
PROJECT NAME: Hendrick Auto Tech Building	DRILLER/CONTRACTOR: Mid Atlantic Drilling, Inc.			

SITE LOCATION: 1042 Hamlet Ave, Hamlet, North Carolina, 28345			LOSS OF CIRCULATION	
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION: 294	BOTTOM OF CASING

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %	
									20	40	60	80	100	1	2	3
35	S-9	SS	18	18	(CL) SANDY LEAN CLAY, gray, wet, hard to very hard		259	7-26-35 (61)	⊗ 61							
40	S-10	SS	18	18			254	7-23-26 (49)	⊗ 49							
END OF BORING AT 40 FT																

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

<input checked="" type="checkbox"/> WL (First Encountered) 8.00	BORING STARTED: Aug 28 2023	CAVE IN DEPTH:
<input checked="" type="checkbox"/> WL (Completion)	BORING COMPLETED: Aug 28 2023	HAMMER TYPE: Auto
<input checked="" type="checkbox"/> WL (Seasonal High Water)	EQUIPMENT: Track	LOGGED BY: OMA
<input checked="" type="checkbox"/> WL (Stabilized)		DRILLING METHOD: Mud rotary

GEOTECHNICAL BOREHOLE LOG

APPENDIX C – Laboratory Testing

Laboratory Test Results Summary

Laboratory Testing Summary

Sample Location	Sample Number	Depth (ft)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-02	S-2	3.5-5.0	20.4	*SC	45	15	30	32.5					
B-03	S-1	1.0-2.5	10.3	*SC	35	14	21	24.3					

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

Project: Hendrick Auto Tech Building
 Client: Richmond Community College

Project No.: 33:6568
 Date Reported: 9/11/2023



Office / Lab
 ECS Southeast LLP - Wilmington

Address
 6714 Netherlands Drive
 Wilmington, NC 28405

Office Number / Fax
 (910)686-9114
 (910)686-9666

Tested by	Checked by	Approved by	Date Received
		MYoung1	

**INSTRUCTIONS TO BIDDERS
AND
GENERAL CONDITIONS OF THE CONTRACT**

STANDARD FORM FOR CONSTRUCTION PROJECTS

**STATE CONSTRUCTION OFFICE
NORTH CAROLINA
DEPARTMENT OF ADMINISTRATION**

Form OC-15

This document is intended for use on State capital construction projects and shall not be used on any project that is not reviewed and approved by the State Construction Office. Extensive modification to the General Conditions by means of “Supplementary General Conditions” is strongly discouraged. State agencies and institutions may include special requirements in “Division 1 – General Requirements” of the specifications, where they do not conflict with the General Conditions.

**Twenty Fourth Edition January 2013
Revision 1 - May 2024: Article 23.b**

INSTRUCTIONS TO BIDDERS

For a proposal to be considered it must be in accordance with the following instructions:

1. PROPOSALS

Proposals must be made in strict accordance with the Form of Proposal provided therefor, and all blank spaces for bids, alternates, and unit prices applicable to bidder's work shall be properly filled in. When requested alternates are not bid, the proposer shall so indicate by the words "No Bid". Any blanks shall also be interpreted as "No Bid". The bidder agrees that bid on Form of Proposal detached from specifications will be considered and will have the same force and effect as if attached thereto. Photocopied or faxed proposals will not be considered. Numbers shall be stated both in writing and in figures for the base bids and alternates. If figures and writing differ, the written number will supersede the figures.

Any modifications to the Form of Proposal (including alternates and/or unit prices) will disqualify the bid and may cause the bid to be rejected.

The bidder shall fill in the Form of Proposal as follows:

- a. If the documents are executed by a sole owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.
- b. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.
- c. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.
- d. If the proposal is made by a joint venture, it shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable.
- e. All signatures shall be properly witnessed.
- f. If the contractor's license of a bidder is held by a person other than an owner, partner or officer of a firm, then the licensee shall also sign and be a party to the proposal. The title "Licensee" shall appear under his/her signature.

Proposals should be addressed as indicated in the Advertisement for Bids and be delivered, enclosed in an opaque sealed envelope, marked "Proposal" and bearing the title of the work, name of the bidder, and the contractor's license number of the bidder. Bidders should clearly mark on the outside of the bid envelope which contract(s) they are bidding.

Bidder shall identify on the bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts or an affidavit indicating work under contract will be self-performed, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f). Failure to comply with these requirements is grounds for rejection of the bid.

For projects bid in the single-prime alternative, the names and license numbers of major subcontractors shall be listed on the proposal form.

It shall be the specific responsibility of the bidder to deliver his bid to the proper official at the selected place and prior to the announced time for the opening of bids. Later delivery of a bid for any reason, including delivery by any delivery service, shall disqualify the bid.

Unit prices quoted in the proposal shall include overhead and profit and shall be the full compensation for the contractor's cost involved in the work. See General Conditions, Article 19c-1.

2. EXAMINATION OF CONDITIONS

It is understood and mutually agreed that by submitting a bid the bidder acknowledges that he has carefully examined all documents pertaining to the work, the location, accessibility and general character of the site of the work and all existing buildings and structures within and adjacent to the site, and has satisfied himself as to the nature of the work, the condition of existing buildings and structures, the conformation of the ground, the character, quality and quantity of the material to be encountered, the character of the equipment, machinery, plant and any other facilities needed preliminary to and during prosecution of the work, the general and local conditions, the construction hazards, and all other matters, including, but not limited to, the labor situation which can in any way affect the work under the contract, and including all safety measures required by the Occupational Safety and Health Act of 1970 and all rules and regulations issued pursuant thereto. It is further mutually agreed that by submitting a proposal the bidder acknowledges that he has satisfied himself as to the feasibility and meaning of the plans, drawings, specifications and other contract documents for the construction of the work and that he accepts all the terms, conditions and stipulations contained therein; and that he is prepared to work in cooperation with other contractors performing work on the site.

Reference is made to contract documents for the identification of those surveys and investigation reports of subsurface or latent physical conditions at the site or otherwise affecting performance of the work which have been relied upon by the designer in preparing the documents. The owner will make copies of all such surveys and reports available to the bidder upon request.

Each bidder may, at his own expense, make such additional surveys and investigations as he may deem necessary to determine his bid price for the performance of the work. Any on-site investigation shall be done at the convenience of the owner. Any reasonable request for access to the site will be honored by the owner.

3. BULLETINS AND ADDENDA

Any addenda to specifications issued during the time of bidding are to be considered covered in the proposal and in closing a contract they will become a part thereof. It shall be the bidder's responsibility to ascertain prior to bid time the addenda issued and to see that his bid includes any changes thereby required.

Should the bidder find discrepancies in, or omission from, the drawings or documents or should he be in doubt as to their meaning, he shall at once notify the designer who will send written instructions in the form of addenda to all bidders. Notification should be no later than seven (7) days prior to the date set for receipt of bids. Neither the owner nor the designer will be responsible for any oral instructions.

All addenda should be acknowledged by the bidder(s) on the Form of Proposal. However, even if not acknowledged, by submitting a bid, the bidder has certified that he has reviewed all issued addenda and has included all costs associated within his bid.

4. BID SECURITY

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company insured by the Federal Deposit Insurance Corporation, or a bid bond in an amount equal to not less than five percent (5%) of the proposal, said deposit to be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten (10) days after the award or to give satisfactory surety as required by law (G.S. 143-129).

Bid bond shall be conditioned that the surety will, upon demand, forthwith make payment to the obligee upon said bond if the bidder fails to execute the contract. The owner may retain bid securities of any bidder(s) who may have a reasonable chance of award of contract for the full duration of time stated in the Notice to Bidders. Other bid securities may be released sooner, at the discretion of the owner. All bid securities (cash or certified checks) shall be returned to the bidders promptly after award of contracts, and no later than seven (7) days after expiration of the holding period stated in the Notice to Bidders. Standard Form of Bid Bond is included in these specifications and shall be used.

5. RECEIPT OF BIDS

Bids shall be received in strict accordance with requirements of the General Statutes of North Carolina. Bid security shall be required as prescribed by statute. Prior to the closing of the bid, the bidder will be permitted to change or withdraw his bid. Guidelines for opening of public construction bids are available from the State Construction Office.

6. OPENING OF BIDS

Upon opening, all bids shall be read aloud. Once bidding is closed, there shall not be any withdrawal of bids by any bidder and no bids may be returned by the designer to any bidder. After the opening of bids, no bid may be withdrawn, except under the provisions of General Statute 143-129.1, for a period of thirty days unless otherwise specified. Should the successful bidder default and fail to execute a contract, the contract may be awarded to the next lowest and responsible bidder. The owner reserves the unqualified right to reject any and all bids. Reasons for rejection may include, but shall not be limited to, the following:

- a. If the Form of Proposal furnished to the bidder is not used or is altered.
- b. If the bidder fails to insert a price for all bid items, alternate and unit prices requested.
- c. If the bidder adds any provisions reserving the right to accept or reject any award.
- d. If there are unauthorized additions or conditional bids, or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.
- e. If the bidder fails to complete the proposal form where information is requested so the bid may be properly evaluated by the owner.
- f. If the unit prices contained in the bid schedule are unacceptable to the owner and the State Construction Office.
- g. If the bidder fails to comply with other instructions stated herein.

7. BID EVALUATION

The award of the contract will be made to the lowest responsible bidder as soon as practical. The owner may award on the basis of the base bid and any alternates the owner chooses.

Before awarding a contract, the owner may require the apparent low bidder to qualify himself to be a responsible bidder by furnishing any or all of the following data:

- a. The latest financial statement showing assets and liabilities of the company or other information satisfactory to the owner.
- b. A listing of completed projects of similar size.
- c. Permanent name and address of place of business.
- d. The number of regular employees of the organization and length of time the organization has been in business under present name.
- e. The name and home office address of the surety proposed and the name and address of the responsible local claim agent.
- f. The names of members of the firms who hold appropriate trade licenses, together with license numbers.
- g. If prequalified, contractor info will be reviewed and evaluated comparatively to submitted prequalification package.

Failure or refusal to furnish any of the above information, if requested, shall constitute a basis for disqualification of any bidder.

In determining the lowest responsible, responsive bidder, the owner shall take into consideration the bidder's compliance with the requirements of G.S. 143-128.2(c), the past performance of the bidder on construction contracts for the State with particular concern given to completion times, quality of work, cooperation with other contractors, and cooperation with the designer and owner. Failure of the low bidder to furnish affidavit and/or documentation as required by G.S. 143-128.2(c) shall constitute a basis for disqualification of the bid.

Should the owner adjudge that the apparent low bidder is not the lowest responsible, responsive bidder by virtue of the above information, said apparent low bidder will be so notified and his bid security shall be returned to him.

8. PERFORMANCE BOND

The successful bidder, upon award of contract, shall furnish a performance bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

9. PAYMENT BOND

The successful bidder, upon award of contract, shall furnish a payment bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

10. PAYMENTS

Payments to the successful bidders (contractors) will be made on the basis of monthly estimates. See Article 31, General Conditions.

11. PRE-BID CONFERENCE

Prior to the date set for receiving bids, the Designer may arrange and conduct a Pre-Bid Conference for all prospective bidders. The purpose of this conference is to review project requirements and to respond to questions from prospective bidders and their subcontractors or material suppliers related to the intent of bid documents. Attendance by prospective bidders shall be as required by the "Notice to Bidders".

12. SUBSTITUTIONS

In accordance with the provisions of G.S. 133-3, material, product, or equipment substitutions proposed by the bidders to those specified herein can only be considered during the bidding phase until ten (10) days prior to the receipt of bids when submitted to the Designer with sufficient data to confirm material, product, or equipment equality. Proposed substitutions submitted after this time will be considered only as potential change order.

Submittals for proposed substitutions shall include the following information:

- a. Name, address, and telephone number of manufacturer and supplier as appropriate.
- b. Trade name, model or catalog designation.
- c. Product data including performance and test data, reference standards, and technical descriptions of material, product, or equipment. Include color samples and samples of available finishes as appropriate.
- d. Detailed comparison with specified products including performance capabilities, warranties, and test results.
- e. Other pertinent data including data requested by the Designer to confirm product equality.

If a proposed material, product, or equipment substitution is deemed equal by the Designer to those specified, all bidders of record will be notified by Addendum.

GENERAL CONDITIONS OF THE CONTRACT

The use or reproduction of this document or any part thereof is authorized for and limited to use on projects of the State of North Carolina, and is distributed by, through and at the discretion of the State Construction Office, Raleigh, North Carolina, for that distinct and sole purpose.

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ARTICLE 1 - DEFINITIONS

- a. The **contract documents** consist of the Notice to Bidders; Instructions to Bidders; General Conditions of the Contract; special conditions if applicable; Supplementary General Conditions; the drawing and specifications, including all bulletins, addenda or other modifications of the drawings and specifications incorporated into the documents prior to their execution; the proposal; the contract; the performance bond; the payment bond; insurance certificates; the approval of the attorney general; and the certificate of the Office of State Budget and Management. All of these items together form the contract.
- b. The **owner** is the State of North Carolina through the agency named in the contract.
- c. The **designer(s)** are those referred to within this contract, or their authorized representatives. The Designer(s), as referred to herein, shall mean architect and/or engineer. They will be referred to hereinafter as if each were of the singular number, masculine gender.
- d. The **contractor**, as referred to hereinafter, shall be deemed to be either of the several contracting parties called the "Party of the First Part" in either of the several contracts in connection with the total project. Where, in special instances hereinafter, a particular contractor is intended, an adjective precedes the word "contractor," as "general," "heating," etc. For the purposes of a single prime contract, the term Contractor shall be deemed to be the single contracting entity identified as the "Party of the First Part" in the single Construction Contract. Any references or adjectives that name or infer multiple prime contractors shall be interpreted to mean the single prime Contractor.
- e. A **subcontractor**, as the term is used herein, shall be understood to be one who has entered into a direct contract with a contractor, and includes one who furnishes materials worked to a special design in accordance with plans and specifications covered by the contract, but does not include one who only sells or furnishes materials not requiring work so described or detailed.
- f. **Written notice** shall be defined as notice in writing delivered in person to the contractor, or to a partner of the firm in the case of a partnership, or to a member of the contracting organization, or to an officer of the organization in the case of a corporation, or sent to the last known business address of the contracting organization by registered mail.
- g. **Work**, as used herein as a noun, is intended to include materials, labor, and workmanship of the appropriate contractor.
- h. The **project** is the total construction work to be performed under the contract documents by the several contractors.
- i. **Project Expediter**, as used herein, is an entity stated in the contract documents, designated to effectively facilitate scheduling and coordination of work activities. See Article 14(f) for responsibilities of a Project Expediter. **For the purposes of a single prime contract, the single prime contractor shall be designated as the Project Expediter.**
- j. **Change order**, as used herein, shall mean a written order to the contractor subsequent to the signing of the contract authorizing a change in the contract. The change order shall be signed by the contractor, designer and the owner, and approved by the State Construction Office, in that order (Article 19).

- k. **Field Order**, as used herein, shall mean a written approval for the contractor to proceed with the work requested by owner prior to issuance of a formal Change Order. The field order shall be signed by the contractor, designer, owner, and State Construction Office.
- l. **Time of completion**, as stated in the contract documents, is to be interpreted as consecutive calendar days measured from the date established in the written Notice to Proceed, or such other date as may be established herein (Article 23).
- m. **Liquidated damages**, as stated in the contract documents [, is an amount reasonably estimated in advance to cover the consequential damages associated with the Owner's economic loss in not being able to use the Project for its intended purposes at the end of the contract's completion date as amended by change order, if any, by reason of failure of the contractor(s) to complete the work within the time specified. Liquidated damages does not include the Owner's extended contract administration costs (including but not limited to additional fees for architectural and engineering services, testing services, inspection services, commissioning services, etc.), such other damages directly resulting from delays caused solely by the contractor, or consequential damages that the Owner identified in the bid documents that may be impacted by any delay caused solely by the Contractor (e.g., if a multi-phased project-subsequent phases, delays in start other projects that are dependent on the completion of this Project, extension of leases and/or maintenance agreements for other facilities).
- n. **Surety**, as used herein, shall mean the bonding company or corporate body which is bound with and for the contractor, and which engages to be responsible for the contractor and his acceptable performance of the work.
- o. **Routine written communications between the Designer and the Contractor** are any communication other than a "request for information" provided in letter, memo, or transmittal format, sent by mail, courier, electronic mail, or facsimile. Such communications can not be identified as "request for information".
- p. **Clarification or Request for information (RFI)** is a request from the Contractor seeking an interpretation or clarification by the Designer relative to the contract documents. The RFI, which shall be labeled (RFI), shall clearly and concisely set forth the issue or item requiring clarification or interpretation and why the response is needed. The RFI must set forth the Contractor's interpretation or understanding of the contract documents requirements in question, along with reasons for such an understanding.
- q. **Approval** means written or imprinted acknowledgement that materials, equipment or methods of construction are acceptable for use in the work.
- r. **Inspection** shall mean examination or observation of work completed or in progress to determine its compliance with contract documents.
- s. **"Equal to" or "approved equal"** shall mean materials, products, equipment, assemblies, or installation methods considered equal by the bidder in all characteristics (physical, functional, and aesthetic) to those specified in the contract documents. Acceptance of equal is subject to approval of Designer and owner.
- t. **"Substitution" or "substitute"** shall mean materials, products, equipment, assemblies, or installation methods deviating in at least one characteristic (physical, functional, or aesthetic) from those specified, but which in the opinion of the bidder would improve competition and/or enhance the finished installation. Acceptance of substitution is subject to the approval of the Designer and owner.

- u. **Provide** shall mean furnish and install complete in place, new, clean, operational, and ready for use.
- v. **Indicated and shown** shall mean provide as detailed, or called for, and reasonably implied in the contract documents.
- w. **Special inspector** is one who inspects materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the approved construction documents and referenced standards.
- x. **Commissioning** is a quality assurance process that verifies and documents that building components and systems operate in accordance to the owner's project requirements and the project design documents.
- y. **Designer Final Inspection** is the inspection performed by the design team to determine the completeness of the project in accordance with approved plans and specifications. This inspection occurs prior to SCO final inspection.
- z. **SCO Final Inspection** is the inspection performed by the State Construction Office to determine the completeness of the project in accordance with NC Building Codes and approved plans and specifications.
- aa. **Beneficial Occupancy** is requested by the owner and is occupancy or partial occupancy of the building after all life safety items have been completed as determined by the State Construction Office. Life safety items include but not limited to fire alarm, sprinkler, egress and exit lighting, fire rated walls, egress paths and security.
- bb. Final Acceptance is the date in which the State Construction Office accepts the construction as totally complete. This includes the SCO Final Inspection and certification by the designer that all punch lists are completed.

ARTICLE 2 - INTENT AND EXECUTION OF DOCUMENTS

- a. The drawings and specifications are complementary, one to the other, and that which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a bid for a complete job. In case of discrepancy or disagreement in the contract documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.
- b. The wording of the specifications shall be interpreted in accordance with common usage of the language except that words having a commonly used technical or trade meaning shall be so interpreted in preference to other meanings.
- c. The contractor shall execute each copy of the proposal, contract, performance bond and payment bond as follows:
 - 1. If the documents are executed by a sole owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.
 - 2. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.

3. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.
4. If the documents are made by a joint venture, they shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable to each particular member.
5. All signatures shall be properly witnessed.
6. If the contractor's license is held by a person other than an owner, partner or officer of a firm, then the licensee shall also sign and be a party to the contract. The title "Licensee" shall appear under his/her signature.
7. The bonds shall be executed by an attorney-in-fact. There shall be attached to each copy of the bond a certified copy of power of attorney properly executed and dated.
8. Each copy of the bonds shall be countersigned by an authorized individual agent of the bonding company licensed to do business in North Carolina. The title "Licensed Resident Agent" shall appear after the signature.
9. The seal of the bonding company shall be impressed on each signature page of the bonds.
10. The contractor's signature on the performance bond and the payment bond shall correspond with that on the contract. The date of performance and payment bond shall not be prior to the date of the contract.

ARTICLE 3 - CLARIFICATIONS AND DETAIL DRAWINGS

- a. In such cases where the nature of the work requires clarification by the designer, such clarification shall be furnished by the designer with reasonable promptness by means of written instructions or detail drawings, or both. Clarifications and drawings shall be consistent with the intent of contract documents, and shall become a part thereof.
- b. The contractor(s) and the designer shall prepare, if deemed necessary, a schedule fixing dates upon which foreseeable clarifications will be required. The schedule will be subject to addition or change in accordance with progress of the work. The designer shall furnish drawings or clarifications in accordance with that schedule. The contractor shall not proceed with the work without such detail drawings and/or written clarifications.

ARTICLE 4 - COPIES OF DRAWINGS AND SPECIFICATIONS

The designer or Owner shall furnish free of charge to the contractors electronic copies of plans and specifications. If requested by the contractor, paper copies of plans and specifications shall be furnished free of charge as follows:

- a. General contractor - Up to twelve (12) sets of general contractor drawings and specifications, up to six (6) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

- b. Each other contractor - Up to six (6) sets of the appropriate drawings and specifications, up to three (3) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.
- c. Additional sets shall be furnished at cost, including mailing, to the contractor upon request by the contractor. This cost shall be stated in the bidding documents.
- d. For the purposes of a single-prime contract, the contractor shall receive up to 30 sets of drawings and specifications, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLES, DATA

- a. Within 15 consecutive calendar days after the notice to proceed, each prime contractor shall submit a schedule for submission of all shop drawings, product data, samples, and similar submittals through the Project Expediter to the Designer. This schedule shall indicate the items, relevant specification sections, other related submittal, data, and the date when these items will be furnished to the designer.
- b. The Contractor(s) shall review, approve and submit to the Designer all Shop Drawings, Coordination Drawings, Product Data, Samples, Color Charts, and similar submittal data required or reasonably implied by the Contract Documents. Required Submittals shall bear the Contractor's stamp of approval, any exceptions to the Contract Documents shall be noted on the submittals, and copies of all submittals shall be of sufficient quantity for the Designer to retain up to three (3) copies of each submittal for his own use plus additional copies as may be required by the Contractor. Submittals shall be presented to the Designer in accordance with the schedule submitted in paragraph (a). so as to cause no delay in the activities of the Owner or of separate Contractors.
- c. The Designer shall review required submittals promptly, noting desired corrections if any, and retaining three (3) copies (1 for the Designer, 1 for the owner and 1 for SCO) for his use. The remaining copies of each submittal shall be returned to the Contractor not later than twenty (20) days from the date of receipt by the Designer, for the Contractor's use or for corrections and resubmittal as noted by the Designer. When resubmittals are required, the submittal procedure shall be the same as for the original submittals.
- d. Approval of shop drawings/submittals by the Designer shall not be construed as relieving the Contractor from responsibility for compliance with the design or terms of the contract documents nor from responsibility of errors of any sort in the shop drawings, unless such lack of compliance or errors first have been called in writing to the attention of the Designer by the Contractor.

ARTICLE 6 - WORKING DRAWINGS AND SPECIFICATIONS AT THE JOB SITE

- a. The contractor shall maintain, in readable condition at his job office, one complete set of working drawings and specifications for his work including all shop drawings. Such drawings and specifications shall be available for use by the designer, his authorized representative, owner or State Construction Office.

- b. The contractor shall maintain at the job office, a day-to-day record of work-in-place that is at variance with the contract documents. Such variations shall be fully noted on project drawings by the contractor and submitted to the designer upon project completion and no later than 30 days after final acceptance of the project.
- c. The contractor shall maintain at the job office a record of all required tests that have been performed, clearly indicating the scope of work inspected and the date of approval or rejection.

ARTICLE 7 - OWNERSHIP OF DRAWINGS AND SPECIFICATIONS

All drawings and specifications are instruments of service and remain the property of the owner. The use of these instruments on work other than this contract without permission of the owner is prohibited. All copies of drawings and specifications other than contract copies shall be returned to the owner upon request after completion of the work.

ARTICLE 8 - MATERIALS, EQUIPMENT, EMPLOYEES

- a. The contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, heat, sanitary facilities, water, scaffolding and incidentals necessary for the completion of his work, and shall install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same, and shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto, as shown on the plans, stated in the specifications, or reasonably implied therefrom, all in accordance with the contract documents.
- b. All materials shall be new and of quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.
- c. Upon notice, the contractor shall furnish evidence as to quality of materials.
- d. Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed. However, the contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. Request for substitution of materials, items, or equipment shall be submitted to the designer for approval or disapproval; such approval or disapproval shall be made by the designer prior to the opening of bids. Alternate materials may be requested after the award if it can clearly be demonstrated that it is an added benefit to the owner and the designer and owner approves.
- e. The designer is the judge of equality for proposed substitution of products, materials or equipment.

- g. If at any time during the construction and completion of the work covered by these contract documents, the language, conduct, or attire of any workman of the various crafts be adjudged a nuisance to the owner or designer, or if any workman be considered detrimental to the work, the contractor shall order such parties removed immediately from grounds.

ARTICLE 9 - ROYALTIES, LICENSES AND PATENTS

It is the intention of the contract documents that the work covered herein will not constitute in any way infringement of any patent whatsoever unless the fact of such patent is clearly evidenced herein. The contractor shall protect and save harmless the owner against suit on account of alleged or actual infringement. The contractor shall pay all royalties and/or license fees required on account of patented articles or processes, whether the patent rights are evidenced hereinafter.

ARTICLE 10 - PERMITS, INSPECTIONS, FEES, REGULATIONS

- a. The contractor shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the contractor observes that the drawings and specifications are at variance therewith, he shall promptly notify the designer in writing. See Instructions to Bidders, Paragraph 3, Bulletins and Addenda. Any necessary changes required after contract award shall be made by change order in accordance with Article 19. If the contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the designer, he shall bear all cost arising therefrom. Additional requirements implemented after bidding will be subject to equitable negotiations.
- b. All work under this contract shall conform to the North Carolina State Building Code and other State, local and national codes as are applicable. The cost of all required inspections and permits shall be the responsibility of the contractor and included within the bid proposal. All water taps, meter barrels, vaults and impact fees shall be paid by the contractor unless otherwise noted.
- d. Projects constructed by the State of North Carolina or by any agency or institution of the State are not subject to inspection by any county or municipal authorities and are not subject to county or municipal building codes. The contractor shall, however, cooperate with the county or municipal authorities by obtaining building permits. Permits shall be obtained at no cost.
- e. Projects involving local funding (community colleges) are subject also to county and municipal building codes and inspection by local authorities. The contractor shall pay the cost of these permits and inspections.

ARTICLE 11 - PROTECTION OF WORK, PROPERTY AND THE PUBLIC

- a. The contractors shall be jointly responsible for the entire site and the building or construction of the same and provide all the necessary protections, as required by the owner or designer, and by laws or ordinances governing such conditions. They shall be responsible for any damage to the owner's property, or of that of others on the job, by them, their personnel, or their subcontractors, and shall make good such damages. They shall be responsible for and pay for any damages caused to the owner. All contractors shall have access to the project at all times.
- b. The contractor shall provide cover and protect all portions of the structure when the work is not in progress, provide and set all temporary roofs, covers for doorways, sash and windows, and all other materials necessary to protect all the work on the building, whether set by him, or any of the subcontractors. Any work damaged through the lack of proper protection or from any other cause, shall be repaired or replaced without extra cost to the owner.
- c. No fires of any kind will be allowed inside or around the operations during the course of construction without special permission from the designer and owner.
- d. The contractor shall protect all trees and shrubs designated to remain in the vicinity of the operations by building substantial boxes around same. He shall barricade all walks, roads, etc., as directed by the designer to keep the public away from the construction. All trenches, excavations or other hazards in the vicinity of the work shall be well barricaded and properly lighted at night.
- e. The contractor shall provide all necessary safety measures for the protection of all persons on the job, including the requirements of the A.G.C. *Accident Prevention Manual in Construction*, as amended, and shall fully comply with all state laws or regulations and North Carolina State Building Code requirements to prevent accident or injury to persons on or about the location of the work. He shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. He shall protect against damage or injury resulting from falling materials and he shall maintain all protective devices and signs throughout the progress of the work.
- f. The contractor shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926, published in Volume 39, Number 122, Part II, June 24, 1974, *Federal Register*), and revisions thereto as adopted by General Statutes of North Carolina 95-126 through 155.
- g. The contractor shall designate a responsible person of his organization as safety officer/inspector to inspect the project site for unsafe health and safety hazards, to report these hazards to the contractor for correction, and whose duties also include accident prevention on the project, and to provide other safety and health measures on the project site as required by the terms and conditions of the contract. The name of the safety inspector shall be made known to the designer and owner at the time of the preconstruction conference and in all cases prior to any work starting on the project.
- h. In the event of emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the contractor is hereby authorized to act at his own discretion, without further authorization from anyone, to prevent such threatened injury or damage.

Any compensation claimed by the contractor on account of such action shall be determined as provided for under Article 19(b).

- i. Any and all costs associated with correcting damage caused to adjacent properties of the construction site or staging area shall be borne by the contractor. These costs shall include but not be limited to flooding, mud, sand, stone, debris, and discharging of waste products.

ARTICLE 12 - SEDIMENTATION POLLUTION CONTROL ACT OF 1973

- a. Any land-disturbing activity performed by the contractor(s) in connection with the project shall comply with all erosion control measures set forth in the contract documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).
- b. Upon receipt of notice that a land-disturbing activity is in violation of said act, the contractor(s) shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said act are promptly taken.
- c. The contractor(s) shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this article.
- d. To the fullest extent permitted by law, the contractor(s) shall indemnify and hold harmless the owner, the designer and the agents, consultants and employees of the owner and designer, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this article.

ARTICLE 13 - INSPECTION OF THE WORK

- a. It is a condition of this contract that the work shall be subject to inspection during normal working hours and during any time work is in preparation and progress by the designer, designated official representatives of the owner, State Construction Office and those persons required by state law to test special work for official approval. The contractor shall therefore provide safe access to the work at all times for such inspections.
- b. All instructions to the contractor will be made only by or through the designer or his designated project representative. Observations made by official representatives of the owner shall be conveyed to the designer for review and coordination prior to issuance to the contractor.
- c. All work shall be inspected by designer, special inspector and/or State Construction Office prior to being covered by the contractor. Contractor shall give a minimum two weeks notice unless otherwise agreed to by all parties. If inspection fails, after the first reinspection all costs associated with additional reinspections shall be borne by the contractor.

- d. Where special inspection or testing is required by virtue of any state laws, instructions of the designer, specifications or codes, the contractor shall give adequate notice to the designer of the time set for such inspection or test, if the inspection or test will be conducted by a party other than the designer. Such special tests or inspections will be made in the presence of the designer, or his authorized representative, and it shall be the contractor's responsibility to serve ample notice of such tests.
- e. All laboratory tests shall be paid by the owner unless provided otherwise in the contract documents except the general contractor shall pay for laboratory tests to establish design mix for concrete, and for additional tests to prove compliance with contract documents where materials have tested deficient except when the testing laboratory did not follow the appropriate ASTM testing procedures.
- f. Should any work be covered up or concealed prior to inspection and approval by the designer, special inspector, and/or State Construction Office such work shall be uncovered or exposed for inspection, if so requested by the designer in writing. Inspection of the work will be made upon notice from the contractor. All cost involved in uncovering, repairing, replacing, recovering and restoring to design condition, the work that has been covered or concealed will be paid by the contractor involved.

ARTICLE 14 - CONSTRUCTION SUPERVISION AND SCHEDULE

- a. Throughout the progress of the work, each contractor shall keep at the job site, a competent superintendent and supervisory staff satisfactory to the designer and the owner. The superintendent and supervisory staff shall not be changed without the consent of the designer and owner unless said superintendent ceases to be employed by the contractor or ceases to be competent as determined by the contractor, designer or owner. The superintendent and other staff designated by the contractor in writing shall have authority to act on behalf of the contractor, and instructions, directions or notices given to him shall be as binding as if given to the contractor. However, directions, instructions, and notices shall be confirmed in writing.
- b. The contractor shall examine and study the drawings and specifications and fully understand the project design, and shall provide constant and efficient supervision to the work. Should he discover any discrepancies of any sort in the drawings or specifications, he shall report them to the designer without delay. He will not be held responsible for discrepancies in the drawings and/or specifications, but shall be held responsible to report them should they become known to him.
- c. All contractors shall be required to cooperate and consult with each other during the construction of this project. Prior to installation of work, all contractors shall jointly prepare coordination drawings, showing locations of various ductworks, piping, motors, pumps, and other mechanical or electrical equipment, in relation to the structure, walls and ceilings. These drawings shall be submitted to the designer through the Project Expediter for information only. Each contractor shall lay out and execute his work to cause the least delay to other contractors. Each contractor shall be financially responsible for any damage to other contractor's work and for undue delay caused to other contractors on the project.
- d. The contractor is required to attend job site progress conferences as called by the designer. The contractor shall be represented at these job progress conferences by both home office and project personnel. These representatives shall have authority to act on behalf of the contractor. These meetings shall be open to subcontractors, material

suppliers and any others who can contribute toward maintaining required job progress. It shall be the principal purpose of these meetings, or conferences, to effect coordination, cooperation and assistance in every practical way toward the end of maintaining progress of the project on schedule and to complete the project within the specified contract time. Each contractor shall be prepared to assess progress of the work as required in his particular contract and to recommend remedial measures for correction of progress as may be appropriate. The designer or his authorized representative shall be the coordinator of the conferences and shall preside as chairman. The contractor shall turn over a copy of his daily reports to the Designer and Owner at the job site progress conference. Owner will determine daily report format.

- e The contractor(s) shall, employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a bench mark in a location where same will not be disturbed and where direct instruments sights may be taken.
- f. The designer shall designate a Project Expediter on projects involving two or more prime contracts. The Project Expediter shall be designated in the Supplementary General Conditions. The Project Expediter shall have at a minimum the following responsibilities.
 - 1. Prepare the project construction schedule and shall allow all prime contractors (multi-prime contract) and subcontractors (single-prime contract) performing general, plumbing, HVAC, and electrical work equal input into the preparation of the initial construction schedule.
 - 2. Maintain a project progress schedule for all contractors.
 - 3. Give adequate notice to all contractors to ensure efficient continuity of all phases of the work.
 - 4. Notify the designer of any changes in the project schedule.
 - 5. Recommend to the owner whether payment to a contractor shall be approved.
- g. It shall be the responsibility of the Project Expediter to cooperate with and obtain from several prime contractors and subcontractors on the job, their respective work activities and integrate these activities into a project construction schedule in form of a detailed bar chart or Critical Path Method (CPM), schedule. Each prime contractor shall provide work activities within fourteen (14) days of request by the Project Expediter. A “work activity”, for scheduling purposes, shall be any component or contractual requirement of the project requiring at least one (1) day, but not more than fourteen (14) days, to complete or fulfill. The project construction schedule shall graphically show all salient features of the work required to construct the project from start to finish and within the allotted time established in the contract. The time (in days) between the contractor’s early completion and contractual completion dates is part of the project total float time; and shall be used as such, unless amended by a change order. On a multi-prime project, each prime contractor shall review the proposed construction schedule and approve same in writing. The Project Expediter shall submit the proposed construction schedule to the designer for comments. The complete Project construction schedule shall be of the type set forth in the Supplementary General Condition or subparagraph (1) or (2) below, as appropriate:

1. For a project with total contracts of \$500,000 or less, a bar chart schedule will satisfy the above requirement. The schedule shall indicate the estimated starting and completion dates for each major element of the work.
2. For a project with total contracts over \$500,000, a Critical Path Method (CPM) schedule shall be utilized to control the planning and scheduling of the Work. The CPM schedule shall be the responsibility of the Project Expediter and shall be paid for by the Project Expediter.

Bar Chart Schedule: Where a bar chart schedule is required, it shall be time-scaled in weekly increments, shall indicate the estimated starting and completion dates for each major element of the work by trade and by area, level, or zone, and shall schedule dates for all salient features, including but not limited to the placing of orders for materials, submission of shop drawings and other Submittals for approval, approval of shop drawings by designers, the manufacture and delivery of material, the testing and the installation of materials, supplies and equipment, and all Work activities to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s). Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

CPM Schedule: Where a CPM schedule is required, it shall be in time-scaled precedence format using the Project Expediter's logic and time estimates. The CPM schedule shall be drawn or plotted with activities grouped or zoned by Work area or subcontract as opposed to a random (or scattered) format. The CPM schedule shall be time-scaled on a weekly basis and shall be drawn or plotted at a level of detail and logic which will schedule all salient features of the work to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s).. Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

The CPM schedule will identify and describe each activity, state the duration of each activity, the calendar dates for the early and late start and the early and late finish of each activity, and clearly highlight all activities on the critical path. "Total float" and "free float" shall be indicated for all activities. Float time shall not be considered for the exclusive use or benefit of either the Owner or the Contractor, but must be allocated in the best interest of completing the Work within the Contract time. Extensions to the Contract time, when granted by Change Order, will be granted only when equitable time adjustment exceeds the Total Float in the activity or path of activities affected by the change. On contracts with a price over \$2,500,000, the CPM schedule shall also show what part of the Contract Price is attributable to each activity on the schedule, the sum of which for all activities shall equal the total Contract Price.

Early Completion of Project: The Contractor may attempt to complete the project prior to the Contract Completion Date. However, such planned early completion shall be for the Contractor's convenience only and shall not create any additional rights of the Contractor or obligations of the Owner under this Contract, nor shall it change the Time

for Completion or the Contract Completion Date. The Contractor shall not be required to pay liquidated damages to the Owner because of its failure to complete by its planned earlier date. Likewise, the Owner shall not pay the Contractor any additional compensation for early completion nor will the Owner owe the Contractor any compensation should the Owner, its officers, employees, or agents cause the Contractor not to complete earlier than the date required by the Contract Documents.

- h. The proposed project construction schedule shall be presented to the designer no later than fifteen (15) days after written notice to proceed. No application for payment will be processed until this schedule is accepted by the designer and owner.
- i. The approved project construction schedule shall be distributed to all contractors and displayed at the job site by the Project Expediter.
- j. The several contractors shall be responsible for their work activities and shall notify the Project Expediter of any necessary changes or adjustments to their work. The Project Expediter shall maintain the project construction schedule, making biweekly adjustments, updates, corrections, etc., that are necessary to finish the project within the Contract time, keeping all contractors and the designer fully informed. Copy of a bar chart schedule annotated to show the current progress shall be submitted by the Contractor(s) to the designer, along with monthly request for payment. For project requiring CPM schedule, the Contractor shall submit a biweekly report of the status of all activities. The bar chart schedule or status report shall show the actual Work completed to date in comparison with the original Work scheduled for all activities. If any activities of the work of several contractors are behind schedule, the contractor must indicate in writing, what measures will be taken to bring each such activity back on schedule and to ensure that the Contract Completion Date is not exceeded. A plan of action and recovery schedule shall be developed and submitted to the designer by the Project Expediter, when (1) the contractor's report indicates delays, that are in the opinion of the designer or the owner, of sufficient magnitude that the contractor's ability to complete the work by the scheduled completion is brought into question; (2) the updated construction schedule is thirty (30) days behind the planned or baseline schedule and no legitimate time extensions, as determined by the Designer, are in process; and (3) the contractor desires to make changes in the logic (sequencing of work) or the planned duration of future activities of the CPM schedule which, in the opinion of the designer or the owner, are of a major nature. The plan of action, when required shall be submitted to the Owner for review within two (2) business days of the Contractor receiving the Owner's written demand. The recovery schedule, when required, shall be submitted to the Owner within five (5) calendar days of the Contractor's receiving the Owner's written demand. Failure to provide an updated construction schedule or a recovery schedule may be grounds for rejection of payment applications or withholding of funds as set forth in Article 33.
- k. The Project Expediter shall notify each contractor of such events or time frames that are critical to the progress of the job. Such notice shall be timely and reasonable. Should the progress be delayed due to the work of any of the several contractors, it shall be the duty of the Project Expediter to immediately notify the contractor(s) responsible for such delay, the designer, the State Construction Office and other prime contractors. The designer shall determine the contractor(s) who caused the delays and notify the bonding company of the responsible contractor(s) of the delays; and shall make a recommendation to the owner regarding further action.
- l. Designation as Project Expediter entails an additional project control responsibility and does not alter in any way the responsibility of the contractor so designated, nor the

responsibility of the other contractors involved in the project. The project expeditor's Superintendent(s) shall be in attendance at the Project site at all times when work is in progress unless conditions are beyond the control of the Contractor or until termination of the Contract in accordance with the Contract Documents. It is understood that such Superintendent shall be acceptable to the Owner and Designer and shall be the one who will be continued in that capacity for the duration of the project unless he ceases to be on the Contractor's payroll or the Owner otherwise agrees. The Superintendent shall not be employed on any other project for or by the Contractor or by any other entity during the course of the Work. If the Superintendent is employed by the Contractor on another project without the Owner's approval, then the Owner may deduct from the Contractor's monthly general condition costs and amount representing the Superintendent's cost and shall deduct that amount for each month thereafter until the Contractor has the Superintendent back on the Owner's Project full-time.

ARTICLE 15 - SEPARATE CONTRACTS AND CONTRACTOR RELATIONSHIPS

- a. Effective from January 1, 2002, Chapter 143, Article 8, was amended, to allow public contracts to be delivered by the following delivery methods: single-prime, dual (single-prime and separate-prime), construction manager at risk, and alternative contracting method as approved by the State Building Commission. The owner reserves the right to prepare separate specifications, receive separate bids, and award separate contracts for such other major items of work as may be in the best interest of the State. For the purposes of a single prime contract, refer to Article 1 – Definitions.
- b. All contractors shall cooperate with each other in the execution of their work, and shall plan their work in such manner as to avoid conflicting schedules or delay of the work. See Article 14, Construction Supervision.
- c. If any part of contractor's work depends upon the work of another contractor, defects which may affect that work shall be reported to the designer in order that prompt inspection may be made and the defects corrected. Commencement of work by a contractor where such condition exists will constitute acceptance of the other contractor's work as being satisfactory in all respects to receive the work commenced, except as to defects which may later develop. The designer shall be the judge as to the quality of work and shall settle all disputes on the matter between contractors.
- d. Any mechanical or electrical work such as sleeves, inserts, chases, openings, penetrations, etc., which is located in the work of the general contractor shall be built in by the general contractor. The respective mechanical and electrical contractors shall set all sleeves, inserts and other devices that are to be incorporated into the structure in cooperation and under the supervision of the general contractor. The responsibility for the exact location of such items shall be that of the mechanical and/or electrical contractor.
- e. The designer and the owner shall have access to the work whenever it is in preparation and progress and during normal working hours. The contractor shall provide facilities for such access so the designer may perform his functions under the contract documents.
- f. Should a contractor cause damage to the work or property of another contractor, he shall be directly responsible, and upon notice, shall promptly settle the claim or otherwise resolve the dispute.

ARTICLE 16 - SUBCONTRACTS AND SUBCONTRACTORS

- a. Within thirty (30) days after award of the contract, the contractor shall submit to the designer, owner and to the State Construction Office a list giving the names and addresses of subcontractors and equipment and material suppliers he proposes to use, together with the scope of their respective parts of the work. Should any subcontractor be disapproved by the designer or owner, the designer or owner shall submit his reasons for disapproval in writing to the State Construction Office for its consideration with a copy to the contractor. If the State Construction Office concurs with the designer's or owner's recommendation, the contractor shall submit a substitute for approval. The designer and owner shall act promptly in the approval of subcontractors, and when approval of the list is given, no changes of subcontractors will be permitted except for cause or reason considered justifiable by the designer or owner.
- b. The designer will furnish to any subcontractor, upon request, evidence regarding amounts of money paid to the contractor on account of the subcontractor's work.
- c. The contractor is and remains fully responsible for his own acts or omissions as well as those of any subcontractor or of any employee of either. The contractor agrees that no contractual relationship exists between the subcontractor and the owner in regard to the contract, and that the subcontractor acts on this work as an agent or employee of the contractor.
- d. The owner reserves the right to limit the amount of portions of work to be subcontracted as hereinafter specified.

ARTICLE 17 - CONTRACTOR AND SUBCONTRACTOR RELATIONSHIPS

The contractor agrees that the terms of these contract documents shall apply equally to each subcontractor as to the contractor, and the contractor agrees to take such action as may be necessary to bind each subcontractor to these terms. The contractor further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to contractor-subcontractor relationships, and that payments to subcontractors shall be made in accordance with the provisions of G.S. 143-134.1 titled Interest on final payments due to prime contractors: payments to subcontractors.

- a. On all public construction contracts which are let by a board or governing body of the state government or any political subdivision thereof, except contracts let by the Department of Transportation pursuant to G.S. 136-28.1, the balance due prime contractors shall be paid in full within 45 days after respective prime contracts of the project have been accepted by the owner, certified by the architect, engineer or designer to be completed in accordance with terms of the plans and specifications, or occupied by the owner and used for the purpose for which the project was constructed, whichever occurs first. Provided, however, that whenever the architect or consulting engineer in charge of the project determines that delay in completion of the project in accordance with terms of the plans and specifications is the fault of the contractor, the project may be occupied and used for the purposes for which it was constructed without payment of any interest on amounts withheld past the 45 day limit. No payment shall be delayed because of the failure of another prime contractor on such project to complete his contract. Should final payment to any prime contractor beyond the date such contracts have been certified to be completed by the designer or architect, accepted by the owner, or occupied by the owner and used for the purposes for which the project was constructed, be delayed by more than 45 days, said prime contractor shall be paid interest, beginning on the 46th day, at the rate of one percent (1%) per month or fraction thereof unless a lower rate is

agreed upon on such unpaid balance as may be due. In addition to the above final payment provisions, periodic payments due a prime contractor during construction shall be paid in accordance with the payment provisions of the contract documents or said prime contractor shall be paid interest on any such unpaid amount at the rate stipulated above for delayed final payments. Such interest shall begin on the date the payment is due and continue until the date on which payment is made. Such due date may be established by the terms of the contract. Funds for payment of such interest on state-owned projects shall be obtained from the current budget of the owning department, institution or agency. Where a conditional acceptance of a contract exists, and where the owner is retaining a reasonable sum pending correction of such conditions, interest on such reasonable sum shall not apply.

- b. Within seven days of receipt by the prime contractor of each periodic or final payment, the prime contractor shall pay the subcontractor based on work completed or service provided under the subcontract. Should any periodic or final payment to the subcontractor be delayed by more than seven days after receipt of periodic or final payment by the prime contractor, the prime contractor shall pay the subcontractor interest, beginning on the eighth day, at the rate of one percent (1%) per month or fraction thereof on such unpaid balance as may be due.
- c. The percentage of retainage on payments made by the prime contractor to the subcontractor shall not exceed the percentage of retainage on payments made by the owner to the prime contractor. Any percentage of retainage on payments made by the prime contractor to the subcontractor that exceeds the percentage of retainage on payments made by the owner to the prime contractor shall be subject to interest to be paid by the prime contractor to the subcontractor at the rate of one percent (1%) per month or fraction thereof.
- d. Nothing in this section shall prevent the prime contractor at the time of application and certification to the owner from withholding application and certification to the owner for payment to the subcontractor for unsatisfactory job progress; defective construction not remedied; disputed work; third-party claims filed or reasonable evidence that claim will be filed; failure of subcontractor to make timely payments for labor, equipment and materials; damage to prime contractor or another subcontractor; reasonable evidence that subcontract cannot be completed for the unpaid balance of the subcontract sum; or a reasonable amount for retainage not to exceed the initial percentage retained by owner.

ARTICLE 18 - DESIGNER'S STATUS

- a. The designer shall provide general administration of the performance of construction contracts, including liaison and necessary inspection of the work to ensure compliance with plans and specifications. He is the agent of the owner only for the purpose of constructing this work and to the extent stipulated in the contract documents. He has authority to direct work to be performed, to stop work, to order work removed, or to order corrections of faulty work, where any such action by the designer may be necessary to assure successful completion of the work.
- b. The designer is the impartial interpreter of the contract documents, and, as such, he shall exercise his powers under the contract to enforce faithful performance by both the owner and the contractor, taking sides with neither.
- c. Should the designer cease to be employed on the work for any reason whatsoever, then the owner shall employ a competent replacement who shall assume the status of the former designer.

- d. The designer and his consultants will make inspections of the project. He will inspect the progress, the quality and the quantity of the work.
- e. The designer and the owner shall have access to the work whenever it is in preparation and progress during normal working hours. The contractor shall provide facilities for such access so the designer and owner may perform their functions under the contract documents.
- f. Based on the designer's inspections and evaluations of the project, the designer shall issue interpretations, directives and decisions as may be necessary to administer the project. His decisions relating to artistic effect and technical matters shall be final, provided such decisions are within the limitations of the contract.

ARTICLE 19 - CHANGES IN THE WORK

- a. The owner may have changes made in the work covered by the contract. These changes will not invalidate and will not relieve or release the contractor from any guarantee given by him pertinent to the contract provisions. These changes will not affect the validity of the guarantee bond and will not relieve the surety or sureties of said bond. All extra work shall be executed under conditions of the original contract.
- b. Except in an emergency endangering life or property, no change shall be made by the contractor except upon receipt of approved change order or written field order from the designer, countersigned by the owner and the state construction office authorizing such change. No claim for adjustments of the contract price shall be valid unless this procedure is followed.

A field order, transmitted by fax, electronically, or hand delivered, may be used where the change involved impacts the critical path of the work. A formal change order shall be issued as expeditiously as possible.

In the event of emergency endangering life or property, the contractor may be directed to proceed on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the designer or owner, a correct account of costs together with all proper invoices, payrolls and supporting data. Upon completion of the work the change order will be prepared as outlined under either Method "c(1)" or Method "c(2)" or both.

- c. In determining the values of changes, either additive or deductive, contractors are restricted to the use of the following methods:
 - 1. Where the extra work involved is covered by unit prices quoted in the proposal, or subsequently agreed to by the Contractor, Designer, Owner and State Construction Office the value of the change shall be computed by application of unit prices based on quantities, estimated or actual as agreed of the items involved, except in such cases where a quantity exceeds the estimated quantity allowance in the contract by one hundred percent (100%) or more. In such cases, either party may elect to proceed under subparagraph c2 herein. If neither party elects to proceed under c2, then unit prices shall apply.
 - 2. The contracting parties shall negotiate and agree upon the equitable value of the change prior to issuance of the change order, and the change order shall stipulate the corresponding lump sum adjustment to the contract price.

- d. Under Paragraph "b" and Methods "c(2)" above, the allowances for overhead and profit combined shall be as follows: all contractors (the single contracting entity (prime), his subcontractors(1st tier subs), or their sub-subcontractors (2nd tier subs, 3rd tier subs, etc)) shall be allowed a maximum of 10% on work they each self-perform; the prime contractor shall be allowed a maximum of 5% on contracted work of his 1st tier sub; 1st tier, 2nd tier, 3rd tier, etc contractors shall be allowed a maximum of 2.5% on the contracted work of their subs. ; Under Method "c(1)", no additional allowances shall be made for overhead and profit. In the case of deductible change orders, under Method "c(2)" and Paragraph (b) above, the contractor shall include no less than five percent (5%) profit, but no allowances for overhead.
- e. The term "net cost" as used herein shall mean the difference between all proper cost additions and deductions. The "cost" as used herein shall be limited to the following:
1. The actual costs of materials and supplies incorporated or consumed as part of the work;
 2. The actual costs of labor expended on the project site; labor expended in coordination, change order negotiation, record document maintenance, shop drawing revision or other tasks necessary to the administration of the project are considered overhead whether they take place in an office or on the project site.
 3. The actual costs of labor burden, limited to the costs of social security (FICA) and Medicare/Medicaid taxes; unemployment insurance costs; health/dental/vision insurance premiums; paid employee leave for holidays, vacation, sick leave, and/or petty leave, not to exceed a total of 30 days per year; retirement contributions; worker's compensation insurance premiums; and the costs of general liability insurance when premiums are computed based on payroll amounts; the total of which shall not exceed thirty percent (30%) of the actual costs of labor;
 4. The actual costs of rental for tools, excluding hand tools; equipment; machinery; and temporary facilities required for the work;
 5. The actual costs of premiums for bonds, insurance, permit fees, and sales or use taxes related to the work.

Overtime and extra pay for holidays and weekends may be a cost item only to the extent approved by the owner.

- f. Should concealed conditions be encountered in the performance of the work below grade, or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the contract documents, the contract sum and time for completion may be equitably adjusted by change order upon claim by either party made within thirty (30) days after the condition has been identified. The cost of such change shall be arrived at by one of the foregoing methods. All change orders shall be supported by a unit cost breakdown showing method of arriving at net cost as defined above.
- g. In all change orders, the procedure will be for the designer to request proposals for the change order work in writing. The contractor will provide such proposal and supporting data in suitable format. The designer shall verify correctness. Delay in the processing of the change order due to lack of proper submittal by the contractor of all required supporting data shall not constitute grounds for a time extension or basis of a claim. Within fourteen (14) days after receipt of the contractor's accepted proposal including all supporting documentation required by the designer, the designer shall prepare the change order and forward to the contractor for his signature or otherwise respond, in writing, to

the contractor's proposal. Within seven (7) days after receipt of the change order executed by the contractor, the designer shall, certify the change order by his signature, and forward the change order and all supporting data to the owner for the owner's signature. The owner shall execute the change order and forward to the State Construction Office for final approval, within seven (7) days of receipt. The State Construction Office shall act on the change order within seven (7) days. In case of emergency or extenuating circumstances, approval of changes may be obtained verbally by telephone or field orders approved by all parties, then shall be substantiated in writing as outlined under normal procedure.

- h. At the time of signing a change order, the contractor shall be required to certify as follows:

"I certify that my bonding company will be notified forthwith that my contract has been changed by the amount of this change order, and that a copy of the approved change order will be mailed upon receipt by me to my surety."

- i. A change order, when issued, shall be full compensation, or credit, for the work included, omitted or substituted. It shall show on its face the adjustment in time for completion of the project as a result of the change in the work.
- j. If, during the progress of the work, the owner requests a change order and the contractor's terms are unacceptable, the owner, with the approval of the State Construction Office, may require the contractor to perform such work on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the Designer or owner, a correct account of cost together with all proper invoices, payrolls and supporting data. Upon completion of the work a change order will be prepared with allowances for overhead and profit per paragraph d. above and "net cost" and "cost" per paragraph e. above. Without prejudice, nothing in this paragraph shall preclude the owner from performing or to have performed that portion of the work requested in the change order.

ARTICLE 20 - CLAIMS FOR EXTRA COST

- a. Should the contractor consider that as a result of instructions given by the designer, he is entitled to extra cost above that stated in the contract, he shall give written notice thereof to the designer within seven (7) days without delay. The written notice shall clearly state that a claim for extra cost is being made and shall provide a detailed justification for the extra cost. The contractor shall not proceed with the work affected until further advised, except in emergency involving the safety of life or property, which condition is covered in Article 19(b) and Article 11(h). No claims for extra compensation shall be considered unless the claim is so made. The designer shall render a written decision within seven (7) days of receipt of claim.
- b. The contractor shall not act on instructions received by him from persons other than the designer, and any claims for extra compensation or extension of time on account of such instruction will not be honored. The designer shall not be responsible for misunderstandings claimed by the contractor of verbal instructions which have not been confirmed in writing, and in no case shall instructions be interpreted as permitting a departure from the contract documents unless such instruction is confirmed in writing and supported by a properly authorized change order.
- c. Should a claim for extra compensation that complies with the requirements of (a) above by the contractor and is denied by the designer or owner, and cannot be resolved by a

representative of the State Construction Office, the contractor may request a mediation in connection with GS 143-128(f1) in the dispute resolution rules adopted by the State Building Commission (1 N.C.A.C. 30H .0101 through .1001). If the contractor is unable to resolve its claim as a result of mediation, the contractor may pursue the claim in accordance with the provisions of G.S. 143-135.3, or G.S. 143-135.6 where Community Colleges are the owner, and the following:

1. A contractor who has not completed a contract with a board for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the director of the State Construction Office of the Department of Administration for the amount the contractor claims is due. The director may deny, allow or compromise the claim, in whole or in part. A claim under this subsection is not a contested case under Chapter 150B of the General Statutes.
2. (a) A contractor who has completed a contract with a board for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the director of the State Construction Office of the Department of Administration for the amount the contractor claims is due. The claim shall be submitted within sixty (60) days after the contractor receives a final statement of the board's disposition of his claim and shall state the factual basis for the claim.
 - (b) The director shall investigate a submitted claim within ninety (90) days of receiving the claim, or within any longer time period upon which the director and the contractor agree. The contractor may appear before the director, either in person or through counsel, to present facts and arguments in support of his claim. The director may allow, deny or compromise the claim, in whole or in part. The director shall give the contractor a written statement of the director's decision on the contractor's claim.
 - (c) A contractor who is dissatisfied with the director's decision on a claim submitted under this subsection may commence a contested case on the claim under Chapter 150B of the General Statutes. The contested case shall be commenced within sixty (60) days of receiving the director's written statement of the decision.
 - (d) As to any portion of a claim that is denied by the director, the contractor may, in lieu of the procedures set forth in the preceding subsection of this section, within six (6) months of receipt of the director's final decision, institute a civil action for the sum he claims to be entitled to under the contract by filing a verified complaint and the issuance of a summons in the Superior Court of Wake County or in the superior court of any county where the work under the contract was performed. The procedure shall be the same as in all civil actions except that all issues shall be tried by the judge, without a jury.

ARTICLE 21 - MINOR CHANGES IN THE WORK

The designer will have the authority to order minor changes in the work not involving an adjustment in the contract sum or time for completion, and not inconsistent with the intent of the contract documents. Such changes shall be effected by written order, copied to the State Construction Office, and shall be binding on the owner and the contractor.

ARTICLE 22 - UNCORRECTED FAULTY WORK

Should the correction of faulty or damaged work be considered inadvisable or inexpedient by the owner and the designer, the owner shall be reimbursed by the contractor. A change order will be issued to reflect a reduction in the contract sum.

ARTICLE 23 - TIME OF COMPLETION, DELAYS, EXTENSION OF TIME

- a. The time of completion is stated in the Supplementary General Conditions and in the Form of Construction Contract. The Project Expediter, upon notice of award of contract, shall prepare a construction schedule to complete the project within the time of completion as required by Article 14.
- b. The contractors shall commence work to be performed under this agreement on a date to be specified in a written Notice to Proceed from the designer and shall fully complete all work hereunder within the time of completion stated. Time is of the essence and the contractor acknowledges the Owner will likely suffer financial damage for failure to complete the work within the time of completion. For each day in excess of the above number of days, the contractor(s) shall pay the owner the sum stated as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the owner by reason of failure of said contractor(s) to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof. Should the work be delayed by both the owner and contractor, liquidated damages shall be apportioned to reflect the delays of each party. In the case of concurrent delays, contractor caused delays shall be accounted for before owner and designer caused delays.
- c. In the event of multiple prime contractors, the designer shall be the judge as to the division of responsibility between the contractor(s), based on the construction schedule, weekly reports and job records, and shall apportion the amount of liquidated damages to be paid by each of them, according to delay caused by any or all of them.
- d. If the contractor is delayed at any time in the progress of his work solely by any act or negligence of the owner, the designer, or by any employee of either; by any separate contractor employed by the owner; by changes ordered in the work; by labor disputes at the project site; by abnormal weather conditions not reasonably anticipated for the locality where the work is performed; by unavoidable casualties; by any causes beyond the contractor's control; or by any other causes which the designer and owner determine may justify the delay, then the contract time may be extended by change order only for the time which the designer and owner may determine is reasonable.

Time extensions will not be granted for rain, wind, snow or other natural phenomena of normal intensity for the locality where work is performed. For purpose of determining extent of delay attributable to unusual weather phenomena, a determination shall be made by comparing the weather for the contract period involved with the average of the preceding five (5) year climatic range during the same time interval based on the National Oceanic and Atmospheric Administration National Weather Service statistics for the locality where work is performed and on daily weather logs kept on the job site by the contractor reflecting the effect of the weather on progress of the work and initialed by the designer's representative. No weather delays shall be considered after the building is dried in unless work claimed to be delayed is on the critical path of the baseline schedule or approved updated schedule. Time extensions for weather delays, acts of God, labor disputes, fire, delays in transportation, unavoidable casualties or other delays which are beyond the control of the Owner do not entitle the Contractor to compensable damages for delays. Any contractor claim for compensable damages for delays is limited to delays caused solely by the owner or its agents. Contractor caused delays shall be accounted for before owner or designer caused delays in the case of concurrent delays.

- e. Request for extension of time shall be made in writing to the designer, copies to the owner and SCO, within twenty (20) days following cause of delay. In case of continuing cause for delay, the Contractor shall notify the Designer to the designer, copies to the owner and SCO, of the delay within 20 days of the beginning of the delay and only one claim is necessary.
- f. The contractor shall notify his surety in writing of extension of time granted.
- g. No claim for time extension shall be allowed on account of failure of the designer to furnish drawings or instructions until twenty (20) days after demand for such drawings and/or instructions. See Article 5c. Demand must be in written form clearly stating the potential for delay unless the drawings or instructions are provided. Any delay granted will begin after the twenty (20) day demand period is concluded.

ARTICLE 24 - PARTIAL UTILIZATION/BENEFICIAL OCCUPANCY

- a. The owner may desire to occupy or utilize all or a portion of the project prior to the completion of the project.
- b. Should the owner request a utilization of a building or portion thereof, the designer shall perform a designer final inspection of area after being notified by the contractor that the area is ready for such. After the contractor has completed designer final inspection punch list and the designer has verified, then the designer shall schedule a beneficial occupancy inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office. If beneficial occupancy is granted by the State Construction Office, in such areas the following will be established:
 - 1. The beginning of guarantees and warranties period for the equipment necessary to support. in the area.
 - 2. The owner assumes all responsibilities for utility costs for entire building.
 - 2. Contractor will obtain consent of surety.
 - 3. Contractor will obtain endorsement from insurance company permitting beneficial occupancy.
- c. The owner shall have the right to exclude the contractor from any part of the project which the designer has so certified to be substantially complete, but the owner will allow the contractor reasonable access to complete or correct work to bring it into compliance with the contract.
- d. Occupancy by the owner under this article will in no way relieve the contractor from his contractual requirement to complete the project within the specified time. The contractor will not be relieved of liquidated damages because of beneficial occupancy. The designer may prorate liquidated damages based on the percentage of project occupied.

ARTICLE 25 - FINAL INSPECTION, ACCEPTANCE, AND PROJECT CLOSEOUT

- a. Upon notification from the contractor(s) that the project is complete and ready for inspection, the designer shall make a Designer final inspection to verify that the project is complete and ready for SCO final inspection. Prior to SCO final inspection, the contractor(s) shall complete all items requiring corrective measures noted at the Designer

final inspection. The designer shall schedule a SCO final inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office.

- b. At the SCO final inspection, the designer and his consultants shall, if job conditions warrant, record a list of items that are found to be incomplete or not in accordance with the contract documents. At the conclusion of the SCO final inspection, the designer and State Construction Office representative shall make one of the following determinations:
 - 1. That the project is completed and accepted.
 - 2. That the project will be accepted subject to the correction of the list of discrepancies (punch list). All punch list items must be completed within thirty (30) days of SCO final inspection or the owner may invoke Article 28, Owner's Right to Do Work.
 - 4. That the project is not complete and another date for a SCO final inspection will be established.
- c. Within fourteen (14) days of final acceptance per Paragraph b1 or within fourteen (14) days after completion of punch list per Paragraph b2 above, the designer shall certify the work and issue applicable certificate(s) of compliance.
- d. Any discrepancies listed or discovered after the date of SCO final inspection and acceptance under Paragraphs b1 or b2 above shall be handled in accordance with Article 42, Guarantee.
- f. The final acceptance date will establish the following:
 - 1. The beginning of guarantees and warranties period.
 - 2. The date on which the contractor's insurance coverage for public liability, property damage and builder's risk may be terminated.
 - 3. That no liquidated damages (if applicable) shall be assessed after this date.
 - 4. The termination date of utility cost to the contractor.
- g. Prior to issuance of final acceptance date, the contractor shall have his authorized representatives visit the project and give full instructions to the designated personnel regarding operating, maintenance, care, and adjustment of all equipment and special construction elements. In addition, the contractor shall provide to the owner a complete instructional video (media format acceptable to the owner) on the operation, maintenance, care and adjustment of all equipment and special construction elements.**

ARTICLE 26 - CORRECTION OF WORK BEFORE FINAL PAYMENT

- a. Any work, materials, fabricated items or other parts of the work which have been condemned or declared not in accordance with the contract by the designer shall be promptly removed from the work site by the contractor, and shall be immediately replaced by new work in accordance with the contract at no additional cost to the owner. Work or property of other contractors or the owner, damaged or destroyed by virtue of such faulty work, shall be made good at the expense of the contractor whose work is faulty.

- b. Correction of condemned work described above shall commence within twenty-four (24) hours after receipt of notice from the designer, and shall make satisfactory progress, as determined by the designer, until completed.
- c. Should the contractor fail to proceed with the required corrections, then the owner may complete the work in accordance with the provisions of Article 28.

ARTICLE 27 - CORRECTION OF WORK AFTER FINAL PAYMENT

See Article 35, Performance Bond and Payment Bond, and Article 42, Guarantee. Neither the final certificate, final payment, occupancy of the premises by the owner, nor any provision of the contract, nor any other act or instrument of the owner, nor the designer, shall relieve the contractor from responsibility for negligence, or faulty material or workmanship, or failure to comply with the drawings and specifications. Contractor shall correct or make good any defects due thereto and repair any damage resulting there from, which may appear during the guarantee period following final acceptance of the work except as stated otherwise under Article 42, Guarantee. The owner will report any defects as they may appear to the contractor and establish a time limit for completion of corrections by the contractor. The owner will be the judge as to the responsibility for correction of defects.

ARTICLE 28 - OWNER'S RIGHT TO DO WORK

If, during the progress of the work or during the period of guarantee, the contractor fails to prosecute the work properly or to perform any provision of the contract, the owner, after seven (7) days' written notice sent by certified mail, return receipt requested, to the contractor from the designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the contractor, such action and cost of same having been first approved by the designer. Should the cost of such action of the owner exceed the amount due or to become due the contractor, then the contractor or his surety, or both, shall be liable for and shall pay to the owner the amount of said excess.

ARTICLE 29 - ANNULMENT OF CONTRACT

If the contractor fails to begin the work under the contract within the time specified, or the progress of the work is not maintained on schedule, or the work is not completed within the time above specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the contractor shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the owner may give notice in writing, sent by certified mail, return receipt requested, to the contractor and his surety of such delay, neglect or default, specifying the same, and if the contractor within a period of seven (7) days after such notice shall not proceed in accordance therewith, then the owner shall, declare this contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this contract in the manner and within the time frame specified. In the event the surety shall fail to take over the work to be done under this contract within seven (7) days after being so notified and notify the owner in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the owner shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said contractor, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said contract according to the terms and provisions thereof

or use such other methods as in his opinion shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the owner, together with the costs of completing the work under contract, shall be deducted from any monies due or which may become due said contractor and surety. In case the expense so incurred by the owner shall be less than the sum which would have been payable under the contract, if it had been completed by said contractor, then the said contractor and surety shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the contractor and the surety shall be liable and shall pay to the owner the amount of said excess.

ARTICLE 30 - CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE THE CONTRACT

- a. Should the work be stopped by order of a court having jurisdiction, or by order of any other public authority for a period of three months, due to cause beyond the fault or control of the contractor, or if the owner should fail or refuse to make payment on account of a certificate issued by the designer within forty-five (45) days after receipt of same, then the contractor, after fifteen (15) days' written notice sent by certified mail, return receipt requested, to the owner and the designer, may suspend operations on the work or terminate the contract.
- b. The owner shall be liable to the contractor for the cost of all materials delivered and work performed on this contract plus 10 percent overhead and profit and shall make such payment. The designer shall be the judge as to the correctness of such payment.

ARTICLE 31 - REQUEST FOR PAYMENT

- a. Not later than the fifth day of the month, the contractor shall submit to the designer a request for payment for work done during the previous month. The request shall be in the form agreed upon between the contractor and the designer, but shall show substantially the value of work done and materials delivered to the site during the period since the last payment, and shall sum up the financial status of the contract with the following information:
 1. Total of contract including change orders.
 2. Value of work completed to date.
 3. Less five percent (5%) retainage, provided however, that after fifty percent (50%) of the contractor's work has been satisfactorily completed on schedule, with approval of the owner and the State Construction Office and written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule.
 4. Less previous payments.
 5. Current amount due.
- b. The contractor, upon request of the designer, shall substantiate the request with invoices of vouchers or payrolls or other evidence.
- c. Prior to submitting the first request, the contractor shall prepare for the designer a schedule showing a breakdown of the contract price into values of the various parts of the work, so arranged as to facilitate payments to subcontractors in accordance with Article 17, Contractor and Subcontractor Relationships. The contractor(s) shall list the

value of each subcontractor and supplier, identifying each minority business subcontractor and supplier as listed in Affidavit C, if applicable.

- d. When payment is made on account of stored materials and equipment, such materials must be stored on the owner's property, and the requests for payments shall be accompanied by invoices or bills of sale or other evidence to establish the owner's title to such materials and equipment. Such payments will be made only for materials that have been customized or fabricated specifically for this project. Raw materials or commodity products including but not limited to piping, conduit, CMU, metal studs and gypsum board may not be submitted. Responsibility for such stored materials and equipment shall remain with the contractor regardless of ownership title. Such stored materials and equipment shall not be removed from the owner's property. Should the space for storage on-site be limited, the contractor, at his option, shall be permitted to store such materials and/or equipment in a suitable space off-site. Should the contractor desire to include any such materials or equipment in his application for payment, they must be stored in the name of the owner in an independent, licensed, bonded warehouse approved by the designer, owner and the State Construction Office and located as close to the site as possible. The warehouse selected must be approved by the contractor's bonding and insurance companies; the material to be paid for shall be assigned to the owner and shall be inspected by the designer. Upon approval by the designer, owner and SCO of the storage facilities and materials and equipment, payment therefore will be certified. Responsibility for such stored materials and equipment shall remain with the contractor. Such stored materials and equipment shall not be moved except for transportation to the project site. Under certain conditions, the designer may approve storage of materials at the point of manufacture, which conditions shall be approved by the designer, the owner and the State Construction Office prior to approval for the storage and shall include an agreement by the storing party which unconditionally gives the State absolute right to possession of the materials at anytime. Bond, security and insurance protection shall continue to be the responsibility of the contractor(s).
- e. In the event of beneficial occupancy, retainage of funds due the contractor(s) may be reduced with the approval of the State Construction Office to an equitable amount to cover the list of items to be completed or corrected. Retainage may not be reduced to less than two and one-half (2 1/2) times the estimated value of the work to be completed or corrected. Reduction of retainage must be with the consent and approval of the contractor's bonding company.

ARTICLE 32 - CERTIFICATES OF PAYMENT AND FINAL PAYMENT

- a. Within five (5) days from receipt of request for payment from the contractor, the designer shall issue and forward to the owner a certificate for payment. This certificate shall indicate the amount requested or as approved by the designer. If the certificate is not approved by the designer, he shall state in writing to the contractor and the owner his reasons for withholding payment.
- b. No certificate issued or payment made shall constitute an acceptance of the work or any part thereof. The making and acceptance of final payment shall constitute a waiver of all claims by the owner except:
 - 1. Claims arising from unsettled liens or claims against the contractor.
 - 2. Faulty work or materials appearing after final payment.
 - 3. Failure of the contractor to perform the work in accordance with drawings and specifications, such failure appearing after payment.

4. As conditioned in the performance bond and payment bond.
- c. The making and acceptance of final payment shall constitute a waiver of all claims by the contractor except those claims previously made and remaining unsettled (Article 20(c)).
- d. Prior to submitting request for final payment to the designer for approval, the contractor shall fully comply with all requirements specified in the “ project closeout” section of the specifications. These requirements include but not limited to the following:
 1. Submittal of Product and Operating Manuals, Warranties and Bonds, Guarantees, Maintenance Agreements, As-Built Drawings, Certificates of Inspection or Approval from agencies having jurisdiction. (The designer must approve the Manuals prior to delivery to the owner).
 2. Transfer of Required attic stock material and all keys in an organized manner.
 3. Record of Owner’s training.
 4. Resolution of any final inspection discrepancies.
 5. Granting access to Contractor’s records, if Owner’s internal auditors have made a request for such access pursuant to Article 52.
- e. The contractor shall forward to the designer, the final application for payment along with the following documents:
 1. List of minority business subcontractors and material suppliers showing breakdown of contract amounts and total actual payments to subs and material suppliers.
 2. Affidavit of Release of Liens.
 3. Affidavit of contractors of payment to material suppliers and subcontractors. (See Article 36).
 4. Consent of Surety to Final Payment.
 5. Certificates of state agencies required by state law.
- f. The designer will not authorize final payment until the work under contract has been certified by designer, certificates of compliance issued, and the contractor has complied with the closeout requirements. The designer shall forward the contractor’s final application for payment to the owner along with respective certificate(s) of compliance required by law.

ARTICLE 33 - PAYMENTS WITHHELD

- a. The designer with the approval of the State Construction Office may withhold payment for the following reasons:
 1. Faulty work not corrected.

2. The unpaid balance on the contract is insufficient to complete the work in the judgment of the designer.
 3. To provide for sufficient contract balance to cover liquidated damages that will be assessed.
- b. The secretary of the Department of Administration may authorize the withholding of payment for the following reasons:
 1. Claims filed against the contractor or evidence that a claim will be filed.
 2. Evidence that subcontractors have not been paid.
 - c. The Owner may withhold all or a portion of Contractor's general conditions costs set forth in the approved schedule of values, if Contractor has failed to comply with: (1) a request to access its records by Owner's internal auditors pursuant to Article 52; (2) a request for a plan of action and/or recovery schedule under Article 14.j or provide The Owner; (3) a request to provide an electronic copies of Contractor's baseline schedule, updates with all logic used to create the schedules in the original format of the scheduling software; and (4) Contractor's failure to have its Superintendent on the Project full-time; (
 - d. When grounds for withholding payments have been removed, payment will be released. Delay of payment due the contractor without cause will make owner liable for payment of interest to the contractor in accordance with G.S. 143-134.1. As provided in G.S.143-134.1(e) the owner shall not be liable for interest on payments withheld by the owner for unsatisfactory job progress, defective construction not remedied, disputed work, or third-party claims filed against the owner or reasonable evidence that a third-party claim will be filed.

ARTICLE 34 - MINIMUM INSURANCE REQUIREMENTS

The work under this contract shall not commence until the contractor has obtained all required insurance and verifying certificates of insurance have been approved in writing by the owner. These certificates shall document that coverages afforded under the policies will not be cancelled, reduced in amount or coverages eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the owner of such alteration or cancellation. If endorsements are needed to comply with the notification or other requirements of this article copies of the endorsements shall be submitted with the certificates.

a. Worker's Compensation and Employer's Liability

The contractor shall provide and maintain, until final acceptance, workmen's compensation insurance, as required by law, as well as employer's liability coverage with minimum limits of \$100,000.

b. Public Liability and Property Damage

The contractor shall provide and maintain, until final acceptance, comprehensive general liability insurance, including coverage for premises operations, independent contractors, completed operations, products and contractual exposures, as shall protect such contractors from claims arising out of any bodily injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operations be by the contractor or by any subcontractor, or by

anyone directly or indirectly employed by either of them and the minimum limits of such insurance shall be as follows:

Bodily Injury: \$500,000 per occurrence
Property Damage: \$100,000 per occurrence / \$300,000 aggregate

In lieu of limits listed above, a \$500,000 combined single limit shall satisfy both conditions.

Such coverage for completed operations must be maintained for at least two (2) years following final acceptance of the work performed under the contract.

c. Property Insurance (Builder's Risk/Installation Floater)

The contractor shall purchase and maintain property insurance until final acceptance, upon the entire work at the site to the full insurable value thereof. This insurance shall include the interests of the owner, the contractor, the subcontractors and sub-subcontractors in the work and shall insure against the perils of fire, wind, rain, flood, extended coverage, and vandalism and malicious mischief. If the owner is damaged by failure of the contractor to purchase or maintain such insurance, then the contractor shall bear all reasonable costs properly attributable thereto; the contractor shall effect and maintain similar property insurance on portions of the work stored off the site when request for payment per articles so includes such portions.

d. Deductible

Any deductible, if applicable to loss covered by insurance provided, is to be borne by the contractor.

e. Other Insurance

The contractor shall obtain such additional insurance as may be required by the owner or by the General Statutes of North Carolina including motor vehicle insurance, in amounts not less than the statutory limits.

f. Proof of Carriage

The contractor shall furnish the owner with satisfactory proof of carriage of the insurance required before written approval is granted by the owner.

ARTICLE 35 - PERFORMANCE BOND AND PAYMENT BOND

- a. Each contractor shall furnish a performance bond and payment bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount. Bonds shall be executed in the form bound with these specifications.
- b. All bonds shall be countersigned by an authorized agent of the bonding company who is licensed to do business in North Carolina.

ARTICLE 36 - CONTRACTOR'S AFFIDAVIT

The final payment of retained amount due the contractor on account of the contract shall not become due until the contractor has furnished to the owner through the designer an affidavit signed, sworn and notarized to the effect that all payments for materials, services or subcontracted work in connection with his contract have been satisfied, and that no claims or

liens exist against the contractor in connection with this contract. In the event that the contractor cannot obtain similar affidavits from subcontractors to protect the contractor and the owner from possible liens or claims against the subcontractor, the contractor shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the contractor's) knowledge, and if any appear afterward, the contractor shall save the owner harmless.

ARTICLE 37 - ASSIGNMENTS

The contractor shall not assign any portion of this contract nor subcontract in its entirety. Except as may be required under terms of the performance bond or payment bond, no funds or sums of money due or become due the contractor under the contract may be assigned.

ARTICLE 38 - USE OF PREMISES

- a. The contractor(s) shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the designer and owner and shall not exceed those established limits in his operations.
- b. The contractor(s) shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.
- c. The contractor(s) shall enforce the designer's and owner's instructions regarding signs, advertisements, fires and smoking.
- d. No firearms, any type of alcoholic beverages, or drugs (other than those prescribed by a physician) will be permitted at the job site.

ARTICLE 39 - CUTTING, PATCHING AND DIGGING

- a. The contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts come together properly and fit it to receive or be received by work of other contractors shown upon or reasonably implied by the drawings and specifications for the completed structure, as the designer may direct.
- b. Any cost brought about by defective or ill-timed work shall be borne by the party responsible therefor.
- c. No contractor shall endanger any work of another contractor by cutting, digging or other means. No contractor shall cut or alter the work of any other contractor without the consent of the designer and the affected contractor(s).

ARTICLE 40 - UTILITIES, STRUCTURES, SIGNS

- a. The contractor shall provide necessary and adequate facilities for water, electricity, gas, oil, sewer and other utility services which maybe necessary and required for completion of the project including all utilities required for testing, cleaning, balancing, and sterilization of designated plumbing, mechanical and electrical systems. Any permanent meters installed shall be listed in the contractor's name until work has a final acceptance. The contractor will be solely responsible for all utility costs prior to final acceptance. Contractor shall contact all affected utility companies prior to bid to determine their requirements to provide temporary and permanent service and include all costs associated with providing those services in their bid. Coordination of the work of the utility companies during construction is the sole responsibility of the contractor.

- b. Meters shall be relisted in the owner's name on the day following final acceptance of the Project Expediter's work, and the owner shall pay for services used after that date.
- c. The owner shall be reimbursed for all metered utility charges after the meter is relisted in the owner's name and prior to completion and acceptance of the work of **all** contractors. Reimbursement shall be made by the contractor whose work has not been completed and accepted. If the work of two or more contractors has not been completed and accepted, reimbursement to the owner shall be paid by the contractors involved on the basis of assessments by the designer.
- d. Prior to the operation of permanent systems, the Project Expediter will provide temporary power, lighting, water, and heat to maintain space temperature above freezing, as required for construction operations.
- e. All contractors shall have the permanent building systems in sufficient readiness for furnishing temporary climatic control at the time a building is enclosed and secured. The HVAC systems shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishes of the building. A building shall be considered enclosed and secured when windows, doorways (exterior, mechanical, and electrical equipment rooms), and hardware are installed; and other openings have protection which will provide reasonable climatic control. The appropriate time to start the mechanical systems and climatic condition shall be jointly determined by the contractor(s), the designer and owner. Use of the equipment in this manner shall be subject to the approval of the Designer and owner and shall in no way affect the warranty requirements of the contractor(s).
- f. The electrical contractor shall have the building's permanent power wiring distribution system in sufficient readiness to provide power as required by the HVAC contractor for temporary climatic control.
- g. The electrical contractor shall have the building's permanent lighting system ready at the time the general contractor begins interior painting and shall provide adequate lighting in those areas where interior painting and finishing is being performed.
- h. Each prime contractor shall be responsible for his permanently fixed service facilities and systems in use during progress of the work. The following procedures shall be strictly adhered to:
 - 1. Prior to final acceptance of work by the State Construction Office, each contractor shall remove and replace any parts of the permanent building systems damaged through use during construction.
 - 2. Temporary filters as recommended by the equipment manufacturer in order to keep the equipment and ductwork clean and free of dust and debris shall be installed in each of the heating and air conditioning units and at each return grille during construction. New filters shall be installed in each unit prior to the owner's acceptance of the work.
 - 3. Extra effort shall be maintained to keep the building and the site adjacent to the building clean and under no circumstances shall air systems be operated if finishing and site work operations are creating dust in excess of what would be considered normal if the building were occupied.
 - 4. It shall be understood that any warranty on equipment presented to the owner shall extend from the day of final acceptance by the owner. The cost of warranting the

equipment during operation in the finishing stages of construction shall be borne by the contractor whose system is utilized.

5. The electrical contractor shall have all lamps in proper working condition at the time of final project acceptance.
 - i. The Project Expediter shall provide, if required and where directed, a shed for toilet facilities and shall furnish and install in this shed all water closets required for a complete and adequate sanitary arrangement. These facilities will be available to other contractors on the job and shall be kept in a neat and sanitary condition at all times. Chemical toilets are acceptable.
 - j. The Project Expediter shall, if required by the Supplementary General Conditions and where directed, erect a temporary field office, complete with lights, telephone, heat and air conditioning. A portion of this office shall be partitioned off, of sufficient size, for the use of a resident inspector, should the designer so direct.
 - k. On multi-story construction projects, the Project Expediter shall provide temporary elevators, lifts, or other special equipment for the general use of all contractors. The cost for such elevators, lifts or other special equipment and the operation thereof shall be included in the Project Expediter's bid.
 - l. The Project Expediter will erect one sign on the project if required. The sign shall be of sound construction, and shall be neatly lettered with black letters on white background. The sign shall bear the name of the project, and the names of prime contractors on the project, and the name of the designer and consultants. Directional signs may be erected on the owner's property subject to approval of the owner with respect to size, style and location of such directional signs. Such signs may bear the name of the contractor and a directional symbol. No other signs will be permitted except by permission of the owner.

ARTICLE 41 - CLEANING UP

- a. The contractors shall keep the building and surrounding area reasonably free from rubbish at all times, and shall remove debris from the site on a timely basis or when directed to do so by the designer or Project Expediter. The Project Expediter shall provide an on site refuse container(s) for the use of all contractors. Each contractor shall remove their rubbish and debris from the building on a daily basis. The Project Expediter shall broom clean the building as required to minimize dust and dirt accumulation.
- b. The Project Expediter shall provide and maintain suitable all-weather access to the building.
- c. Before final inspection and acceptance of the building, each contractor shall clean his portion of the work, including glass, hardware, fixtures, masonry, tile and marble (using no acid), clean and wax all floors as specified, and completely prepare the building for use by the owner, with no cleaning required by the owner.

ARTICLE 42 - GUARANTEE

- a. The contractor shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the date of final acceptance of the work or beneficial occupancy and shall replace such defective materials or workmanship without cost to the owner.

- b. Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The contractor shall replace such defective equipment or materials, without cost to the owner, within the manufacturer's warranty period.
- c. Additionally, the owner may bring an action for latent defects caused by the negligence of the contractor which is hidden or not readily apparent to the owner at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.
- d. Guarantees for roof, equipment, materials, and supplies shall be stipulated in the specifications sections governing such roof, equipment, materials, or supplies.

ARTICLE 43 - CODES AND STANDARDS

Wherever reference is given to codes, standard specifications or other data published by regulating agencies including, but not limited to, national electrical codes, North Carolina state building codes, federal specifications, ASTM specifications, various institute specifications, etc., it shall be understood that such reference is to the latest edition including addenda published prior to the date of the contract documents.

ARTICLE 44 - INDEMNIFICATION

To the fullest extent permitted by law, the contractor shall indemnify and hold harmless the owner, the designer and the agents, consultants and employees of the owner and designer, from and against all claims, damages, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance or failure of performance of the work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including the loss of use resulting there from, and (2) is caused in whole or in part by any negligent act or omission of the contractor, the contractor's subcontractor, or the agents of either the contractor or the contractor's subcontractor. Such obligation shall not be construed to negate, abridge or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this article.

ARTICLE 45 - TAXES

- a. Federal excise taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3442(3)).
- b. Federal transportation taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3475(b) as amended).
- c. North Carolina sales tax and use tax, as required by law, do apply to materials entering into state work and such costs shall be included in the bid proposal and contract sum.
- d. Local option sales and use taxes, as required by law, do apply to materials entering into state work as applicable and such costs shall be included in the bid proposal and contract sum.
- e. **Accounting Procedures for Refund of County Sales & Use Tax**

Amount of county sales and use tax paid per contractor's statements:

Contractors performing contracts for state agencies shall give the state agency for whose project the property was purchased a signed statement containing the information listed in G.S. 105-164.14(e).

The Department of Revenue has agreed that in lieu of obtaining copies of sales receipts from contractors, an agency may obtain a certified statement as of April 1, 1991 from the contractor setting forth the date, the type of property and the cost of the property purchased from each vendor, the county in which the vendor made the sale and the amount of local sales and use taxes paid thereon. If the property was purchased out-of-state, the county in which the property was delivered should be listed. The contractor should also be notified that the certified statement may be subject to audit.

In the event the contractors make several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, the counties, and the county sales and use taxes paid thereon.

Name of taxing county: The position of a sale is the retailer's place of business located within a taxing county where the vendor becomes contractually obligated to make the sale. Therefore, it is important that the county tax be reported for the county of sale rather than the county of use.

When property is purchased from out-of-state vendors and the county tax is charged, the county should be identified where delivery is made when reporting the county tax.

Such statement must also include the cost of any tangible personal property withdrawn from the contractor's warehouse stock and the amount of county sales or use tax paid thereon by the contractor.

Similar certified statements by his subcontractors must be obtained by the general contractor and furnished to the claimant.

Contractors are not to include any tax paid on supplies, tools and equipment which they use to perform their contracts and should include only those building materials, supplies, fixtures and equipment which actually become a part of or annexed to the building or structure.

ARTICLE 46 - EQUAL OPPORTUNITY CLAUSE

The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to equal employment opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the secretary of Labor, are incorporated herein.

ARTICLE 47 - EMPLOYMENT OF INDIVIDUALS WITH DISABILITIES

The contractor(s) agree not to discriminate against any employee or applicant for employment because of physical or mental disabilities in regard to any position for which the employee or applicant is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified individuals with such disabilities without discrimination based upon their physical or mental disability in all employment practices.

ARTICLE 48 - ASBESTOS-CONTAINING MATERIALS (ACM)

The State of North Carolina has attempted to address all asbestos-containing materials that are to be disturbed in the project. However, there may be other asbestos-containing materials in the work areas that are not to be disturbed and do not create an exposure hazard.

Contractors are reminded of the requirements of instructions under Instructions to Bidders and General Conditions of the Contract, titled Examination of Conditions. Statute 130A, Article 19, amended August 3, 1989, established the Asbestos Hazard Management Program that controls asbestos abatement in North Carolina. The latest edition of *Guideline Criteria for Asbestos Abatement* from the State Construction Office is to be incorporated in all asbestos abatement projects for the Capital Improvement Program.

ARTICLE 49 - MINORITY BUSINESS PARTICIPATION

GS 143-128.2 establishes a ten percent (10%) goal for participation by minority businesses in total value of work for each State building project. The document, *Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts* including Affidavits and Appendix E are hereby incorporated into and made a part of this contract.

ARTICLE 50 – CONTRACTOR EVALUATION

The contractor's overall work performance on the project shall be fairly evaluated in accordance with the State Building Commission policy and procedures, for determining qualifications to bid on future State capital improvement projects. In addition to final evaluation, interim evaluation may be prepared during the progress of project. The document, *Contractor Evaluation Procedures*, is hereby incorporated and made a part of this contract. The owner may request the contractor's comments to evaluate the designer.

ARTICLE 51 – GIFTS

Pursuant to N.C. Gen. Stat. § 133-32, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, subcontractor, supplier, vendor, etc.), to make gifts or to give favors to any State employee. This prohibition covers those vendors and contractors who: (1) have a contract with a governmental agency; or (2) have performed under such a contract within the past year; or (3) anticipate bidding on such a contract in the future. For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review G.S. Sec. 133-32.

During the construction of the Project, the Contractor is prohibited from making gifts to any of the Owner's employees, Owner's project representatives (architect, engineers, construction manager and their employees), employees of the State Construction Office and/or any other State employee that may have any involvement, influence, responsibilities, oversight, management and/or duties that pertain to and/or relate to the contract administration, financial administration and/or disposition of claims arising from and/or relating to the Contract and/or Project.

ARTICLE 52 – AUDITING-ACCESS TO PERSONS AND RECORDS

In accordance with N.C. General Statute 147-64.7, the State Auditor shall have access to Contractor's officers, employees, agents and/or other persons in control of and/or responsible for the Contractor's records that relate to this Contracts for purposes of conducting audits under the referenced statute. The Owner's internal auditors shall also have the right to access and copy the Contractor's records relating to the Contract and Project during the term of the Contract and within two years following the completion of the Project/close-out of the Contract to verify accounts, accuracy, information, calculations and/or data affecting and/or

relating to Contractor's requests for payment, requests for change orders, change orders, claims for extra work, requests for time extensions and related claims for delay/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, and/or any other type of claim for payment or damages from Owner and/or its project representatives.

ARTICLE 53 – NORTH CAROLINA FALSE CLAIMS ACT

The North Carolina False Claims Act ("NCFCA"), N.C. Gen. Stat. § 1-605 through 1-618, applies to this Contract. The Contractor should familiarize itself with the entire NCFCA and should seek the assistance of an attorney if it has any questions regarding the NCFCA and its applicability to any requests, demands and/or claims for payment its submits to the State through the contracting state agency, institution, university or community college.

The purpose of the NCFCA "is to deter persons from knowingly causing or assisting in causing the State to pay claims that are false or fraudulent and to provide remedies in the form of treble damages and civil penalties when money is obtained from the State by reason of a false or fraudulent claim." (Section 1-605(b).) A contractor's liability under the NCFCA may arise from, but is not limited to: requests for payment, invoices, billing, claims for extra work, requests for change orders, requests for time extensions, claims for delay damages/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, documentation used to support any of the foregoing requests or claims, and/or any other request for payment from the State through the contracting state agency, institution, university or community college. The parts of the NCFCA that are most likely to be enforced with respect to this type of contract are as follows:

- A "claim" is "[a]ny request or demand, whether under a contract or otherwise, for money or property and whether or not the State has title to the money or property that (i) is presented to an officer, employee, or agent of the State or (ii) is made to a contractor ... if the money or property is to be spent or used on the State's behalf or to advance a State program or interest and if the State government: (a) provides or has provided any portion of the money or property that is requested or demanded; or (b) will reimburse such contractor ... for any portion of the money or property which is requested or demanded." (Section 1-606(2).)
- "Knowing" and "knowingly." – Whenever a person, with respect to information, does any of the following: (a) Has actual knowledge of the information; (b) Acts in deliberate ignorance of the truth or falsity of the information; and/or (c) Acts in reckless disregard of the truth or falsity of the information. (Section 1-606(4).) Proof of specific intent to defraud is not required. (Section 1-606(4).)
- "Material" means having a natural tendency to influence, or be capable of influencing, the payment or receipt of money or property. (Section 1-606(4).)
- Liability. – "Any person who commits any of the following acts shall be liable to the State for three times the amount of damages that the State sustains because of the act of that person[:] ... (1) Knowingly presents or causes to be presented a false or fraudulent claim for payment or approval. (2) Knowingly makes, uses, or causes to be made or used, a false record or statement material to a false or fraudulent claim. (3) Conspires to commit a violation of subdivision (1), (2) ..." (Section 1-607(a)(1), (2).)

- The NCFCA shall be interpreted and construed so as to be consistent with the federal False Claims Act, 31 U.S.C. § 3729, et seq., and any subsequent amendments to that act. (Section 1-616(c).)

Finally, the contracting state agency, institution, university or community college may refer any suspected violation of the NCFCA by the Contractor to the Attorney General's Office for investigation. Under Section 1-608(a), the Attorney General is responsible for investigating any violation of NCFCA, and may bring a civil action against the Contractor under the NCFCA. The Attorney General's investigation and any civil action relating thereto are independent and not subject to any dispute resolution provision set forth in this Contract. (See Section 1-608(a).)

ARTICLE 54 – TERMINATION FOR CONVENIENCE

Owner may at any time and for any reason terminate Contractor's services and work at Owner's convenience. Upon receipt of such notice, Contractor shall, unless the notice directs otherwise, immediately discontinue the work and placing of orders for materials, facilities and supplies in connection with the performance of this Agreement.

Upon such termination, Contractor shall be entitled to payment only as follows: (1) the actual cost of the work completed in conformity with this Agreement; plus, (2) such other costs actually incurred by Contractor as are permitted by the prime contract and approved by Owner; (3) plus ten percent (10%) of the cost of the work referred to in subparagraph (1) above for overhead and profit. There shall be deducted from such sums as provided in this subparagraph the amount of any payments made to Contractor prior to the date of the termination of this Agreement. Contractor shall not be entitled to any claim or claim of lien against Owner for any additional compensation or damages in the event of such termination and payment.

SECTION 00 73 00 – SUPPLEMENTAL GENERAL CONDITIONS

Below are modifications to the current 24th edition (Revised January 2013) edition of Form OC-15, General Conditions of the Contract.

INSTRUCTIONS TO BIDDERS

Item 6 - Opening of Bids.

Revise “thirty days (30)” in the first paragraph to “sixty (60) calendar days”.

Article 2 - Intent and Execution of Documents.

Add the following:

- d. "Bids.
Bids shall be based on conditions at the site, Specifications and the Drawings.

Prime Contractors shall review the entire set of Drawings and Specifications for related work and coordination between trades.

Article 6 - Working Drawings and Specifications at the Job Site.

- a. Change “Designer” to “Designer, State and Owner”.

Add the following:

- "c. The close-out documents for the Contractor will not be complete until "As-Built Drawings" are turned over to the Designer of record and reviewed and deemed complete in writing by the Designer."

Article 8 - Materials, Equipment, Employees.

Add the following to Subparagraph g:

“and shall not be allowed to return to the project site.”

Add the following Subparagraph h. as follows:

- "h. In making application for substitution, Contractor represents he has personally investigated the proposed product and manufacturer’s installation guidelines, and determined that it is equal or superior in all respects to that specified by placing his/her proper stamp, date, item being substituted for, referenced section of project manual and drawing sheets applicable, and signature on each submittal item. Refer to **Section 01 25 00** for additional substitution requirements."

SECTION 00 73 00 – SUPPLEMENTAL GENERAL CONDITIONS

Article 11 - Protection of Work, Property and Public.

Subparagraph g: Replace “designer” with “Designer, State and Owner”.

Article 14 - Construction Supervision and Schedule.

Item a: Replace “designer” with “Designer, State and Owner”.

Item b: Add the following to Item b: “Where compliance with two or more requirements, material or equipment, are specified and the requirements, materials or equipment, establish conflicting specifications or quality levels, the contractor is to comply with the most stringent or higher quality specification. The Designer shall be the authority for determining the highest quality specification.

Add the following to item c.:

“Each Contractor shall indemnify and save harmless the Owner and Designer for any delay caused to him/her by other Contractors.”

Revise Subparagraph e to read as follows:

“The contractor(s) shall employ a Professional Land Surveyor registered to practice by the State of North Carolina to lay out the work and to establish reference points at nearby locations where same will not be disturbed and where direct instruments sights may be taken to/from bench marks shown on the plans.”

Add the following to item f.:

“Unless designated otherwise, The General Contractor shall be the 'Project Expeditor'.”

6. The Project Expeditor shall prepare daily and have available for inspection by the Designer, State, and Owner daily project reports. Project daily reports shall be prepared for every day of the project beginning with the date of the notice to proceed and terminating with project completion. Daily reports must also be completed for all weekends and holidays. The daily reports are to include the following items (at a minimum): Superintendents name and signature; day and date; morning and afternoon temperature; weather (clear, cloudy, rain and duration of rain); site conditions; other applicable weather conditions; crew sizes for all contractors and subcontractors on site; and major work accomplished for that day.

Article 16 - Subcontracts and Subcontractors.

Subparagraph a: Replace “designer” with “Designer and Owner”.

SECTION 00 73 00 – SUPPLEMENTAL GENERAL CONDITIONS

Article 18 - Designers' Status

Revise the first sentence in Subparagraph e. as follows

- d. "The Designer and Owner shall have access to all parts of the work at all times."

Article 19 - Changes In The Work

Add the following to Subparagraph g as the third sentence:

"The supporting data shall include a summary of materials, labor, unit costs, profit and overhead, etc."

Article 21 - Minor Changes in the Work.

Revise the first sentence by adding after "The Designer..."

"with consultation with the Owner."

Article 23 - Time of Completion, Delays, Extension.

Add the following:

"h. Time.

1. The Contractor shall commence work to be performed under this agreement on a date to be specified in a written order from the designer and shall fully complete all work within 365 consecutive calendar days from, and including said date. For each day in excess of the above number of days, the Contractor shall pay to the Owner the sum of *Seven Hundred Fifty Dollars \$750.00* as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the Owner by reason of failure of said Contractor to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof.
2. The Contractor agrees that said work shall be prosecuted regularly, diligently, and uninterruptedly at such rate or progress as will insure full completion thereof within the time specified.

Article 31 - Request for Payment.

Add the following:

SECTION 00 73 00 – SUPPLEMENTAL GENERAL CONDITIONS

- "f. Contractor shall submit to the Designer a request for payment on a current version of AIA Document G702 unless otherwise approved by the Designer and the Owner."

Article 34 – Minimum Insurance Requirements.

Provide the modification to read as follows:

- "c. This insurance shall include the interests of the Owner, the Contractor, the Subcontractors, and the Sub-subcontractors in the work and shall insure against risks of direct physical loss – (all perils).

Article 40 – Utilities, Structures, Signs.

Add the following to Item i:

- "Portable toilets must be provided on site by the contractor. The Owner's toilet facilities shall not be used at any time during the project."

Add the following to item j.:

- "General Contractor shall provide his own office facility and service hook-up and monthly service fees including; telephone, internet and facsimile machine as required at location on site approved by the Architect and Owner. The Office shall be weather-tight with lighting, electrical outlets, heating, cooling equipment and equipped with sturdy furniture, drawing rack and drawing display table. General Contractor's office shall be large enough for his/her own use and for use as a coordination office to include meeting space with table and chairs for 16 people."

Add the following to item l."

- "A shop drawing of the project identification sign must be approved by the College prior to fabrication. No directional signs will be permitted without the College's permission. Contractors are not permitted to install any sign, anywhere on the site, off the site on College property, or on any equipment on the site, without explicit written approval of the Owner."

Add the following:

- "m. Utility outages and temporary detours necessary for the construction of the project which affect College facilities or activities shall be coordinated with, and approved by the College Project Manager. Such outages and detours include (but are not limited to) electrical, plumbing, fire detection, HVAC, pedestrian and vehicular. Such outages shall be planned by the involved Contractors and

SECTION 00 73 00 – SUPPLEMENTAL GENERAL CONDITIONS

presented to the Owner in a written plan no later than 15 days prior to the needed event. The plan shall describe what facilities are involved, the need for College personnel presence, the names of supervisory personnel to direct the activities, and the expected duration. The Owner maintains the right to schedule the disruption/closure for the weekends and /or Holidays in effect to minimize the inconvenience to the campus community. Contractor(s) will not be entitled to additional compensation or additional contract time due to weekend/holiday scheduling.

Article 42 – Guarantee.

Add the following:

- “e. All Warranty periods to begin at “Final Acceptance” rather than Substantial Completion. See Article 25 of Form OC-15 for clarification.

END OF SUPPLEMENTARY GENERAL CONDITIONS

GUIDELINES FOR RECRUITMENT AND SELECTION OF MINORITY BUSINESSES FOR PARTICIPATION IN STATE CONSTRUCTION CONTRACTS

In accordance with G.S. 143-128.2 (effective January 1, 2002) these guidelines establish goals for minority participation in single-prime bidding, separate-prime bidding, construction manager at risk, and alternative contracting methods, on State construction projects in the amount of \$300,000 or more. The legislation provides that the State shall have a verifiable ten percent (10%) goal for participation by minority businesses in the total value of work for each project for which a contract or contracts are awarded. These requirements are published to accomplish that end.

SECTION A: INTENT

It is the intent of these guidelines that the State of North Carolina, as awarding authority for construction projects, and the contractors and subcontractors performing the construction contracts awarded shall cooperate and in good faith do all things legal, proper and reasonable to achieve the statutory goal of ten percent (10%) for participation by minority businesses in each construction project as mandated by GS 143-128.2. Nothing in these guidelines shall be construed to require contractors or awarding authorities to award contracts or subcontracts to or to make purchases of materials or equipment from minority-business contractors or minority-business subcontractors who do not submit the lowest responsible, responsive bid or bids.

SECTION B: DEFINITIONS

1. Minority - a person who is a citizen or lawful permanent resident of the United States and who is:
 - a. Black, that is, a person having origins in any of the black racial groups in Africa;
 - b. Hispanic, that is, a person of Spanish or Portuguese culture with origins in Mexico, South or Central America, or the Caribbean Islands, regardless of race;
 - c. Asian American, that is, a person having origins in any of the original peoples of the Far East, Southeast Asia and Asia, the Indian subcontinent, the Pacific Islands;
 - d. American Indian, that is, a person having origins in any of the original peoples of North America; or
 - e. Female
2. Minority Business - means a business:
 - a. In which at least fifty-one percent (51%) is owned by one or more minority persons, or in the case of a corporation, in which at least fifty-one percent (51%) of the stock is owned by one or more minority persons or socially and economically disadvantaged individuals; and
 - b. Of which the management and daily business operations are controlled by one or more of the minority persons or socially and economically disadvantaged individuals who own it.
3. Socially and economically disadvantaged individual - means the same as defined in 15 U.S.C. 637. "Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities". "Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged".
4. Public Entity - means State and all public subdivisions and local governmental units.
5. Owner - The State of North Carolina, through the Agency/Institution named in the contract.
6. Designer – Any person, firm, partnership, or corporation, which has contracted with the State of North Carolina to perform architectural or engineering, work.
7. Bidder - Any person, firm, partnership, corporation, association, or joint venture seeking to be awarded a public contract or subcontract.

8. Contract - A mutually binding legal relationship or any modification thereof obligating the seller to furnish equipment, materials or services, including construction, and obligating the buyer to pay for them.
9. Contractor - Any person, firm, partnership, corporation, association, or joint venture which has contracted with the State of North Carolina to perform construction work or repair.
10. Subcontractor - A firm under contract with the prime contractor or construction manager at risk for supplying materials or labor and materials and/or installation. The subcontractor may or may not provide materials in his subcontract.

SECTION C: RESPONSIBILITIES

1. Office for Historically Underutilized Businesses, Department of Administration (hereinafter referred to as HUB Office).

The HUB Office has established a program, which allows interested persons or businesses qualifying as a minority business under G.S. 143-128.2, to obtain certification in the State of North Carolina procurement system. The information provided by the minority businesses will be used by the HUB Office to:

- a. Identify those areas of work for which there are minority businesses, as requested.
- b. Make available to interested parties a list of prospective minority business contractors and subcontractors.
- c. Assist in the determination of technical assistance needed by minority business contractors.

In addition to being responsible for the certification/verification of minority businesses that want to participate in the State construction program, the HUB Office will:

- (1) Maintain a current list of minority businesses. The list shall include the areas of work in which each minority business is interested.
- (2) Inform minority businesses on how to identify and obtain contracting and subcontracting opportunities through the State Construction Office and other public entities.
- (3) Inform minority businesses of the contracting and subcontracting process for public construction building projects.
- (4) Work with the North Carolina trade and professional organizations to improve the ability of minority businesses to compete in the State construction projects.
- (5) The HUB Office also oversees the minority business program by:
 - a. Monitoring compliance with the program requirements.
 - b. Assisting in the implementation of training and technical assistance programs.
 - c. Identifying and implementing outreach efforts to increase the utilization of minority businesses.
 - d. Reporting the results of minority business utilization to the Secretary of the Department of Administration, the Governor, and the General Assembly.

2. State Construction Office

The State Construction Office will be responsible for the following:

- a. Furnish to the HUB Office a minimum of twenty-one days prior to the bid opening the following:
 - (1) Project description and location;
 - (2) Locations where bidding documents may be reviewed;
 - (3) Name of a representative of the owner who can be contacted during the advertising period to advise who the prospective bidders are;
 - (4) Date, time and location of the bid opening.
 - (5) Date, time and location of prebid conference, if scheduled.
- b. Attending scheduled prebid conference, if necessary, to clarify requirements of the general statutes regarding minority-business participation, including the bidders' responsibilities.

- c. Reviewing the apparent low bidders' statutory compliance with the requirements listed in the proposal, that must be complied with, if the bid is to be considered as responsive, prior to award of contracts. The State reserves the right to reject any or all bids and to waive informalities.
- d. Reviewing of minority business requirements at Preconstruction conference.
- e. Monitoring of contractors' compliance with minority business requirements in the contract documents during construction.
- f. Provide statistical data and required reports to the HUB Office.
- g. Resolve any protest and disputes arising after implementation of the plan, in conjunction with the HUB Office.

3. Owner

Before awarding a contract, owner shall do the following:

- a. Develop and implement a minority business participation outreach plan to identify minority businesses that can perform public building projects and to implement outreach efforts to encourage minority business participation in these projects to include education, recruitment, and interaction between minority businesses and non-minority businesses.
- b. Attend the scheduled prebid conference.
- c. At least 10 days prior to the scheduled day of bid opening, notify minority businesses that have requested notices from the public entity for public construction or repair work and minority businesses that otherwise indicated to the Office for Historically Underutilized Businesses an interest in the type of work being bid or the potential contracting opportunities listed in the proposal. The notification shall include the following:
 - 1. A description of the work for which the bid is being solicited.
 - 2. The date, time, and location where bids are to be submitted.
 - 3. The name of the individual within the owner's organization who will be available to answer questions about the project.
 - 4. Where bid documents may be reviewed.
 - 5. Any special requirements that may exist.
- d. Utilize other media, as appropriate, likely to inform potential minority businesses of the bid being sought.
- e. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- f. Review, jointly with the designer, all requirements of G.S. 143-128.2(c) and G.S. 143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with corresponding total dollar value of the bid and affidavit listing good faith efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award to the State Construction Office.
- g. Evaluate documentation to determine good faith effort has been achieved for minority business utilization prior to recommendation of award to State Construction Office.
- h. Review prime contractors' pay applications for compliance with minority business utilization commitments prior to payment.
- i. Make documentation showing evidence of implementation of Owner's responsibilities available for review by State Construction Office and HUB Office, upon request

4. Designer

Under the single-prime bidding, separate prime bidding, construction manager at risk, or alternative contracting method, the designer will:

- a. Attend the scheduled prebid conference to explain minority business requirements to the prospective bidders.
- b. Assist the owner to identify and notify prospective minority business prime and subcontractors of potential contracting opportunities.
- c. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- d. Review jointly with the owner, all requirements of G.S. 143-128.2(c) and G.S.143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with

corresponding total dollar value of the bid and affidavit listing Good Faith Efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award.

- e. During construction phase of the project, review “MBE Documentation for Contract Payment” – (Appendix E) for compliance with minority business utilization commitments. Submit Appendix E form with monthly pay applications to the owner and forward copies to the State Construction Office.
- f. Make documentation showing evidence of implementation of Designer’s responsibilities available for review by State Construction Office and HUB Office, upon request.

5. Prime Contractor(s), CM at Risk, and Its First-Tier Subcontractors

Under the single-prime bidding, the separate-prime bidding, construction manager at risk and alternative contracting methods, contractor(s) will:

- a. Attend the scheduled prebid conference.
- b. Identify or determine those work areas of a subcontract where minority businesses may have an interest in performing subcontract work.
- c. At least ten (10) days prior to the scheduled day of bid opening, notify minority businesses of potential subcontracting opportunities listed in the proposal. The notification will include the following:
 - (1) A description of the work for which the subbid is being solicited.
 - (2) The date, time and location where subbids are to be submitted.
 - (3) The name of the individual within the company who will be available to answer questions about the project.
 - (4) Where bid documents may be reviewed.
 - (5) Any special requirements that may exist, such as insurance, licenses, bonds and financial arrangements.

If there are more than three (3) minority businesses in the general locality of the project who offer similar contracting or subcontracting services in the specific trade, the contractor(s) shall notify three (3), but may contact more, if the contractor(s) so desires.

- d. During the bidding process, comply with the contractor(s) requirements listed in the proposal for minority participation.
- e. Identify on the bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).
- f. Make documentation showing evidence of implementation of PM, CM-at-Risk and First-Tier Subcontractor responsibilities available for review by State Construction Office and HUB Office, upon request.
- g. Upon being named the apparent low bidder, the Bidder shall provide one of the following: (1) an affidavit (Affidavit C) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal; (2) if the percentage is not equal to the applicable goal, then documentation of all good faith efforts taken to meet the goal. Failure to comply with these requirements is grounds for rejection of the bid and award to the next lowest responsible and responsive bidder.
- h. The contractor(s) shall identify the name(s) of minority business subcontractor(s) and corresponding dollar amount of work on the schedule of values. The schedule of values shall be provided as required in Article 31 of the General Conditions of the Contract to facilitate payments to the subcontractors.
- i. The contractor(s) shall submit with each monthly pay request(s) and final payment(s), “MBE Documentation for Contract Payment” – (Appendix E), for designer’s review.
- j. During the construction of a project, at any time, if it becomes necessary to replace a minority business subcontractor, immediately advise the owner, State Construction Office, and the Director of the HUB Office in writing, of the circumstances involved. The prime contractor shall make a good faith effort to replace a minority business subcontractor with another minority business subcontractor.

- k. If during the construction of a project additional subcontracting opportunities become available, make a good faith effort to solicit subbids from minority businesses.
- l. It is the intent of these requirements apply to all contractors performing as prime contractor and first tier subcontractor under construction manager at risk on state projects.

6. Minority Business Responsibilities

While minority businesses are not required to become certified in order to participate in the State construction projects, it is recommended that they become certified and should take advantage of the appropriate technical assistance that is made available. In addition, minority businesses who are contacted by owners or bidders must respond promptly whether or not they wish to submit a bid.

SECTION 4: DISPUTE PROCEDURES

It is the policy of this state that disputes that involves a person's rights, duties or privileges, should be settled through informal procedures. To that end, minority business disputes arising under these guidelines should be resolved as governed under G.S. 143-128(g).

SECTION 5: These guidelines shall apply upon promulgation on state construction projects. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: www.nc-sco.com

SECTION 6: In addition to these guidelines, there will be issued with each construction bid package provisions for contractual compliance providing minority business participation in the state construction program.

MINORITY BUSINESS CONTRACT PROVISIONS (CONSTRUCTION)

APPLICATION:

The **Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts** are hereby made a part of these contract documents. These guidelines shall apply to all contractors regardless of ownership. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: <http://www.nc-sco.com>

MINORITY BUSINESS SUBCONTRACT GOALS:

The goals for participation by minority firms as subcontractors on this project have been set at 10%.

The bidder must identify on its bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit (Affidavit A) listing good faith efforts **or** affidavit (Affidavit B) of self-performance of work, if the bidder will perform work under contract by its own workforce, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).

The lowest responsible, responsive bidder must provide Affidavit C, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal.

OR

Provide Affidavit D, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, **with documentation of Good Faith Effort, if the percentage is not equal to the applicable goal.**

OR

Provide Affidavit B, which includes sufficient information for the State to determine that the bidder does not customarily subcontract work on this type project.

The above information must be provided as required. Failure to submit these documents is grounds for rejection of the bid.

MINIMUM COMPLIANCE REQUIREMENTS:

All written statements, affidavits or intentions made by the Bidder shall become a part of the agreement between the Contractor and the State for performance of this contract. Failure to comply with any of these statements, affidavits or intentions, or with the minority business Guidelines shall constitute a breach of the contract. A finding by the State that any information submitted either prior to award of the contract or during the performance of the contract is inaccurate, false or incomplete, shall also constitute a breach of the contract. Any such breach may result in termination of the contract in accordance with the termination provisions contained in the contract. It shall be solely at the option of the State whether to terminate the contract for breach.

In determining whether a contractor has made Good Faith Efforts, the State will evaluate all efforts made by the Contractor and will determine compliance in regard to quantity, intensity, and results of these efforts. Good Faith Efforts include:

- (1) Contacting minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor or available on State or local government maintained lists at least 10 days before the bid or proposal date and notifying them of the nature and scope of the work to be performed.
- (2) Making the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bid or proposals are due.
- (3) Breaking down or combining elements of work into economically feasible units to facilitate minority participation.
- (4) Working with minority trade, community, or contractor organizations identified by the Office for Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- (5) Attending any prebid meetings scheduled by the public owner.
- (6) Providing assistance in getting required bonding or insurance or providing alternatives to bonding or insurance for subcontractors.
- (7) Negotiating in good faith with interested minority businesses and not rejecting them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- (8) Providing assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisting minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- (9) Negotiating joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- (10) Providing quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

Identification of HUB Certified/ Minority Business Participation

I, _____
(Name of Bidder)

do hereby certify that on this project, we will use the following HUB Certified/ minority business as construction subcontractors, vendors, suppliers or providers of professional services.

Firm Name, Address and Phone #	Work Type	*Minority Category	**HUB Certified (Y/N)

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

** HUB Certification with the state HUB Office required to be counted toward state participation goals.

The total value of minority business contracting will be (\$)_____.

State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of _____

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- 1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- 2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- 3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- 4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- 5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- 6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- 7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- 8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- 9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- 10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

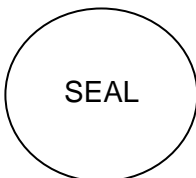
The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract with Own Workforce.

County of _____

Affidavit of _____

(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____

_____ contract.

(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

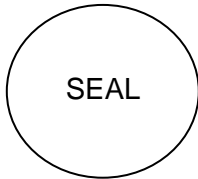
The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement. The Bidder agrees to make a Good Faith Effort to utilize minority suppliers where possible.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20__

Notary Public _____

My commission expires _____

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by HUB Certified/Minority Businesses

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by HUB certified/minority businesses as defined in GS143-128.2(g) and 128.4(a),(b),(e) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit.
 This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the _____
 (Name of Bidder)

_____ (Project Name)
 Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. Attach additional sheets if required

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

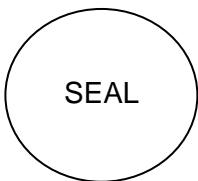
*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____



Signature: _____

Title: _____

State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by HUB Certified/ minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the _____
 (Name of Bidder)

Project ID# _____ (Project Name) Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with HUB certified/ minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. (Attach additional sheets if required)

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Examples of documentation that may be required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

- A. Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.
- B. Copies of quotes or responses received from each firm responding to the solicitation.
- C. A telephone log of follow-up calls to each firm sent a solicitation.
- D. For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.
- E. Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.
- F. Copy of pre-bid roster
- G. Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.
- H. Letter detailing reasons for rejection of minority business due to lack of qualification.
- I. Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

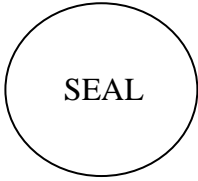
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

APPENDIX E

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

Pay Application #: _____ Period: _____

The following is a list of payments made to Minority Business Enterprises on this project for the above-mentioned period.

MBE FIRM NAME	* INDICATE TYPE OF MBE	AMOUNT PAID THIS MONTH	TOTAL PAYMENTS TO DATE	TOTAL AMOUNT COMMITTED

*Minority categories: Black, African American (B), Hispanic (H), Asian American (A), American Indian (I), Female (F), Social and Economically Disadvantage (D)

Date: _____ Approved/Certified By: _____

Name

_____ Title

_____ Signature

SUBMIT WITH EACH PAY REQUEST & FINAL PAYMENT

Division 01 - General Requirements

SECTION 01 10 00 – SUMMARY OF WORK

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 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification:
 - 1. Project Location: 1042 W. Hamlet Ave - Hamlet, NC 28345
 - 2. Owner: Richmond Community College
- B. Architect Identification: The Contract Documents, date indicated on the Contract Documents, were prepared for Project by ADW Architects.; Six Coliseum, 2815 Coliseum Centre Drive Suite 250 Charlotte, North Carolina 28217. Phone:(704) 379-1919.
- C. The project consists of a new 9,885 s.f. Hendrick Center for Automotive Training. The building is a stand-alone facility adjacent to the Conder Building on RCC's Hamlet campus. The project is a one story building with exterior cladding in materials complementary to the aesthetics of the college's existing buildings – brick, metal panel, and storefront with insulated glazing. The building includes the following spaces: Lobby, Administration, Auto Simulation Lab classrooms, and a 3-bay Lift Bay area for automotive maintenance/repair training.

1.3 CONTRACT[S]

- A. Project will be constructed under **a single prime contract.**

1.4 SITE INVESTIGATION

- A. The Contractor acknowledges that he has satisfied himself as to the nature and location of the Work, the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads and uncertainties of weather, ground water table or similar physical conditions at the site, the conformation and condition of the ground, the character, quality and quantity of surface and subsurface materials to be encountered, the character of equipment and facilities needed prior to and during the performance of the Work and all other matters which can in any way affect the Work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with all the available information concerning these conditions will not relieve him from responsibility for estimating properly the difficulty or cost of successfully performing the Work.

1.5 USE OF PREMISES

- A. Partial Owner Occupancy

1. The Owner reserves the right of partial occupancy or use of facilities, services, and utilities, prior to Substantial Completion, without implying completion or acceptance of any part of the Project.
2. Prior to such occupancy or use, procedures as outlined in the General Conditions of the Contract.
3. The Contractor shall provide access to the building for the Owner's personnel plus provide the correct operation of the heating, ventilation, and air conditioning, and electrical system. Provide for the correct operation of the elevator system for the Owner's use.
4. The Contractor shall also permit the Owner to place and install, or to have other Contractors place and install, as much equipment during the progress of the Work as is possible before the final acceptance of the various parts of the Work, and shall coordinate such placing and installation of the equipment, so that it does not in any way whatever interfere with the progress of the Work or any portion of it.

B. Owner Occupancy

1. Owner will occupy the premises during the entire period of construction to conduct his normal operations. Cooperate with Owner in all construction operations to minimize conflict, and to facilitate Owner usage.
2. Contractor shall at all times conduct his operations as to insure the least inconvenience and the greatest amount of safety and security for the Owner, his staff, and the general public.

1.6 PROTECTION REQUIREMENTS FOR NEW CONSTRUCTION

- A. Protect the existing building from wind, storms, cold heat, water and dust damage of any sort. Provide all equipment and enclosures to maintain this protection and keep the building interior free of water and dust during the life of the Contract.
- B. Provide all shoring and bracing required to maintain the integrity and the safety of the existing structure and for the proper execution of the Work.
- C. Exercise the utmost care to protect all existing utility lines from damage during the progress of the Work.
- D. Provide and erect before any work begins, and maintain during the progress of the Work, all necessary fences, warning signals, signs and lights. Extent of this work and details of construction shall be in accordance with the requirements of all state and local codes.
- E. Any portion of the existing building or existing utility services not included as part of this Contract or any portion of the Work damaged because of failure to provide the protection required shall be removed and replaced with new materials and construction at the Contractor's expense. This work shall be accomplished subject to the Architect's and Owners' approval.

1.7 REPLACEMENT AND REPAIR OF ANY STRUCTURES THAT HAVE BEEN DESTROYED IN THE PROGRESS OF THE WORK:

- A. Because of the installation of the new items of equipment, fixtures, materials, etc., that are required by this Project, it shall become necessary to remove portions of the existing structure, equipment, and/or utility services. Unless specifically noted otherwise on the Drawings, the Contractor shall be responsible for replacing, in a condition of identical appearance, construction, design, working order, and strength as its previous state, any such portion of the

existing structure, equipment, and/or utility services so required to be disturbed. The replaced item shall meet the approval of the Architect before final approval of the Project is given.

1.8 WORK UNDER OTHER CONTRACTS

1.9 FUTURE WORK

1.10 PRODUCTS ORDERED IN ADVANCE

1.11 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish some Cabinets, TV's and audio visual equipment. The Work includes providing support systems to receive Owner's equipment with plumbing, mechanical and electrical connections.
1. Owner will arrange for and deliver Shop Drawings, Product Data, and Samples to Contractor.
 2. Owner will arrange and pay for delivery of Owner-furnished items according to Contractor's Construction Schedule.
 3. After delivery, Owner will inspect delivered items for damage. Contractor shall be present for and assist in Owner's inspection.
 4. If Owner-furnished items are damaged, defective, or missing, Owner will arrange for replacement.
 5. Owner will arrange for manufacturer's field services and for delivery of manufacturer's warranties to Contractor.
 6. Owner will furnish Contractor the earliest possible delivery date for Owner-furnished products. Using Owner-furnished earliest possible delivery dates, Contractor shall designate delivery dates of Owner-furnished items in Contractor's Construction Schedule.
 7. Contractor shall review Shop Drawings, Product Data, and Samples and return them to Architect noting discrepancies or anticipated problems in use of product.
 8. Contractor is responsible for receiving, unloading, and handling Owner-furnished items at Project site.
 9. Contractor is responsible for protecting Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
 10. If Owner-furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them.

1.12 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 49-division format and CSI/CSC's "MasterFormat" numbering system.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for unit prices.
- B. See Division 01 Section "Allowances" for procedures for using unit prices to adjust quantity allowances.

1.2 DEFINITIONS

- A. Unit price is an amount proposed by bidders, stated on the Bid Form, as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.3 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A list of unit prices is included at the end of this Section. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

- A. **Unit Price No. 1:** UNSUITABLE SOIL REMOVAL & IN-PLACE STRUCTURAL FILL
 1. Removal and off-site disposal of unsuitable soil. Measurement shall be by cross section of excavation of the work area (not borrow area). Unit price shall include removal, transportation, off-site disposal, and replacement with suitable fill material.
 2. Unit of Measurement: Cubic Yard.

3. Contractor shall include in the Base Bid **2,500 cubic yards** of unsuitable soil removal. Unit price shall be utilized to make adjustments in actual quantities encountered. Unit price shall include replacement with suitable fill.
- B. Unit Price No. 2: IMPORT FILL**
1. Import suitable fill material as required for grading the site as shown in the Civil drawings. Unit price shall include transportation, and import of suitable fill material.
 2. Unit of Measurement: Cubic Yard.
 3. Contractor shall include in the Base Bid **3,500 cubic yards** of import fill. Unit price shall be utilized to make adjustments in actual quantities encountered. Unit price shall include import, placement, and grading of suitable fill material.
- C. Unit Price No. 3: REMOVAL OF TRENCH ROCK**
1. Removal and on-site disposal of Trench Rock. Measurement shall be by cross section of excavation. Unit price shall include removal, transportation, off-site disposal, and replacement with suitable fill material.
 2. Unit of Measurement: Cubic Yard.
- D. Unit Price No. 4: REMOVAL OF MASS ROCK**
1. Removal and off-site disposal of Mass Rock. Measurement shall be by cross section of excavation. Unit prices shall include removal, transportation, off-site disposal and replacement with suitable fill material.
 2. Unit of Measurement: Cubic Yard.
- E. Unit Price No. 5: IN-PLACE CONCRETE SIDEWALK**
1. Concrete sidewalk. Unit prices shall include removal, transportation, and off-site disposal costs of existing concrete, and replacement with new concrete.
 2. Unit of Measurement: Square Foot (4" thickness)
- F. Unit Price No. 6: STANDARD DUTY ASPHALT PAVING**
1. Description: Standard Duty Asphalt paving - 6" compacted ABC stone with 2" of SF9.5B surface course. Cost should include removal and off-site disposal of existing asphalt pavement and sub-base totaling 8" so the proposed asphalt surface is flush with the surrounding existing surface, including procedures for measurement and payment, according to Division 32.
 2. Unit of Measurement: Square Yard.
- G. Unit Price No. 7: HEAVY DUTY ASPHALT PAVING**
1. Description: Heavy Duty Asphalt paving - 8 1/2" compacted ABC stone with 2 1/2" of I-19B intermediate course and 1 1/2" of SF9.5B surface course. Cost should include removal and off-site disposal of existing asphalt pavement and sub-base totaling 12 1/2" so the proposed asphalt surface is flush with the existing surface, including procedures for measurement and payment, according to Division 32.
 2. Unit of Measurement: Square Yard.
- H. Unit Price No. 8: 2000 PSI LEAN CONCRETE FILL FOR FOOTINGS**
1. Description: 2000 psi lean concrete fill for footings, including procedures for measurement and payment, according to Division 03.
 2. Unit of Measurement: Cubic Yard.
- I. Unit Price No. 9: IRRIGATION LINES**

1. Description: 100 linear feet of 1" PVC Class 200 pipe, 2 rotary spray heads, 2 pop up heads and any associated valves, heads, cements and fittings to provide water supply to landscaped areas.
 2. Unit of Measurement: per 100 Linear Feet.
- G. **Unit Price No. 10:** Emergency Responder Radio System
1. Description: Provide Emergency Responder Radio System (ERRS). See Detail 3/E604 Emergency Responder System Boosting Riser and Specification Section 27 53 19. Room where panel is located shall be 2 hour rated, and access door/frame shall also be 2 hour rated.
 2. System surveys to determine strength of available signal at the site are part of the Base Bid.
 3. Unit of Measurement: One System as specified.

END OF SECTION 01 22 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section summarizes the alternate bids required to be submitted with each Bidder's bid. State in the alternate bids the net sum to be added to, or deducted from the Base Bid in the event the alternate bids are accepted.
- B. Submit alternate bids by filling in blank spaces provided thereof on the Bid Form furnished by the Architect.
- C. The Owner reserves the right to accept or reject any or all of the alternate bids.
- D. Where the description of the alternate bids lists Trade Sections affected by the alternate bid, such a listing shall not necessarily be considered all-inclusive. It shall be the responsibility of each Bidder to determine to his own satisfaction and for his own purposes the limits and extend of the Work affected by the alternate bids and to make full and proper allowance therefore in the submission of his alternate bid proposal.
- E. Include in the alternate bids all changes in cost, either additive or deductive, resulting in the work of all Trade Sections of the Specifications affected thereby. Work required by the alternate bids shall be performed in accordance with applicable Specifications of the Trade Section affected.
- F. Delayed acceptance of the alternate bids: The Owner reserves the right to delay the acceptance of the alternate bids for a period not to exceed 30 calendar days from the time of accepting the general contract without a change in the dollar amount of the alternate bids.

1.02 WORK OF OTHER RELATED SECTIONS:

- A. Pertinent Sections of these Specifications describe the materials and methods required under the various alternates.
- B. The method for stating the proposed Contract Sum is described on the Bid Form.

1.03 SUBMITTALS:

- A. All alternates described in this Section of these Specifications are required to be reflected in the bid submitted on the Bid Form for the Work; however, do not submit alternates other than those specifically allowed in the Documents.

1.04 PRODUCT HANDLING:

- A. If the Owner elects to proceed on the basis of one or more of the alternates, make all modifications to the Work required in the furnishing and installation of the selected alternate or alternates to the approval of the Architect and at no additional cost to the Owner other than as proposed on the Bid Form.

PART 2 - PRODUCTS

- 2.01 ALTERNATE NO. 1 - Provide Schlage Everest keying system. See Specification Section 08 71 00.
- 2.02 ALTERNATE NO. 2 - Provide BACnet DDC system from Alerton. See Specification 23 09 00 Direct Digital Control System.
- 2.03 ALTERNATE NO. 3 - Provide modified bitumen roofing, as manufactured by SOPREMA. See Specification 07 51 00.
- 2.04 ALTERNATE NO. 4 - Masonry/Metal screen wall in lieu of fixed louver screen. See Sheet A900.

PART 3 - EXECUTION

3.01 ADVANCE COORDINATION:

- A. Immediately after award of Contract, and to the maximum extent possible, thoroughly and clearly advise all necessary personnel and suppliers as to the nature and extent of alternatives selected by the Owner; use all means necessary to alert those personnel and suppliers involved as to all changes in the work caused by the Owner's selection of alternatives.

3.02 SURFACE CONDITIONS:

- A. Prior to installation of the alternate items, verify that all surfaces have been modified as necessary to accept the installation and that the time or items may be installed in complete accordance with their manufacturer's current recommendations. In the event of discrepancy, immediately notify the Architect and proceed as he directs.

END OF SECTION 01 23 00

SECTION 01 25 00 - PRODUCT SUBSTITUTIONS-PRIOR TO BID

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. The General Conditions of the Contract for Construction (AIA A201-2007) article 1.2 apply to this section

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling requests for substitutions prior to the Owner's receipt of bids.
- B. The Contractor's Construction Schedule and the Schedule of Submittals are included under Division 01 Section "Construction Progress Documentation".
- C. Standards: Refer to Division 01 Section "References" for applicability of industry standards to products specified.
- D. Procedural requirements governing the Contractor's selection of products and product options are included under Division 01 Section "Quality Requirements".

1.3 DEFINITIONS

- A. Definitions used in this Article are not intended to change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Requests for changes in products, materials, and equipment, of construction required by Contract Documents proposed by the Contractor are considered requests for "substitutions". The following are not considered substitutions:
 - 1. Substitutions that are requested by Bidders beyond the 10 days prior to bid opening submittal period.
 - 2. Revisions to Contract Documents requested by the Owner or Architect.
 - 3. Specified options of products and construction methods included in Contract Documents.
 - 4. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 SUBMITTALS

- A. Substitution Request Submittal: Requests for substitution from prime bidders will be considered if received by the architect ten (10) days prior to the bid opening.
 - 1. Submit three (3) copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required below.

2. Identify the product or the fabrication or installation method to be replaced in each request. Include related specification sections and drawing number.
 3. Provide complete documentation on both the product specified and the proposed substitution including the following information as appropriate.
 - a. Comparison of specified and proposed substitute product data, fabrication drawings, and installation procedures.
 - b. Samples where applicable or requested.
 - c. A detailed comparison of significant qualities of the proposed substitution with those of the work specified.
 - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
 4. Certification by the Contractor or manufacturer that the substitution proposed is equal-to or better in every respect to that required by the Contract Documents, and that it will perform equal or superior to product specified in the application indicated. The Contractor waives any right to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
 5. Architect's Action: The Architect may request additional information or documentation necessary for evaluation of the request. The Architect will notify the Contractors of acceptance of the proposed substitution by means of an addendum to the bid documents. If the proposed substitute is accepted through an addendum use the product specified by name.
- B. Architect/Engineer's Substitution Approval during bidding and subsequent addendums does not void the Contractor's responsibility to submit the required shop drawings and comply with the other contract documents and requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Conditions: The Contractor's substitution request will be received and considered by the Architect when all of the following conditions are satisfied, as determined by the Architect; otherwise requests will be returned without action except to record noncompliance with these requirements.
1. Extensive revisions to Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of Contract Documents.
 3. The request is timely, fully documented and properly submitted.
 4. The request is directly related to an "or equal" clause or similar language in the Contract Documents.
- B. The Contractor's submittal and Architect's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with the Contract Documents does not constitute an approval or valid request for substitution.

PART 3 - EXECUTION

- A. Submit in format as outlined on following page.

PRODUCT SUBSTITUTION

Project _____

Date: _____ Bid Opening Date: _____

Product and / or Fabrication Method: _____

Spec Section: _____

Related Drawings: _____

<u>Criteria or Specified Product</u>	<u>Included</u>
Product Data	_____
Fabrication Drawings	_____
Samples Where Applicable	_____
List of changes or Modifications Needed to Work as Noted in Spec	_____

<u>Criteria or Specified Product</u>	<u>Included</u>
Product Data	_____
Fabrication Drawings	_____
Samples Where Applicable	_____
List of changes or Modifications Needed to Work as Noted in Spec	_____

The substitution proposed is equal-to or better in every respect to that required by the Contract Documents, and it will perform equal or superior to product specified in the application indicated. The Contractor waives right to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.

Signed: _____

END OF SECTION 01 25 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

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. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Preliminary Construction Schedule.
 - 2. Contractor's Construction Schedule.
 - 3. Submittals Schedule.
- B. Related Sections include the following:
 - 1. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 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 activities are activities on the critical path. They must start and finish on the planned early start and early finish times.
 - 2. Predecessor activity is an activity that must be completed before a given activity can be started.
- B. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- C. Major Area: A story of construction, a separate building, or a similar significant construction element.
- D. Milestone: A key or critical point in time for reference or measurement.

1.4 SUBMITTALS

- A. Submittals Schedule: Submit three (3) 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.
- B. Preliminary Construction Schedule: Submit two (2) printed copies; one a single sheet of reproducible media and one a print.
- C. Contractor's Construction Schedule: Submit two (2) printed copies of initial schedule, one a reproducible print color and one a blue- or black-line print, large enough to show entire schedule for entire construction period.
- D. Field Condition Reports: Submit one (1) copy at time of discovery of differing conditions.
- E. Special Reports: Submit one (1) copy at time of unusual event.

1.5 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, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from parties involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CPM CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling."
- B. Conventional Critical Path Method (CPM) Precedence Diagramming Method (PDM) technique shall be utilized to satisfy time applications.
- C. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
- D. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than twenty (20) days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for 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 Submittals Schedule.
 4. Startup and Testing Time: Include not less than ten (10) days for startup and testing.

5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.

- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

2.4 REPORTS

- A. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CPM 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 Actual 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.

END OF SECTION 01 32 00

PROJECT:	Richmond Community College – Hendrick Center for Automotive Training
DATE:	
CONTRACTOR:	

AGREEMENT FOR FILE RELEASE AND USE OF BUILDING INFORMATION MODEL (BIM) BY CONTRACTOR

At your request, ADW Architects, p.a. (ADW) will provide the Contractor, _____, with the Building Information Model (BIM) for the above mentioned project. It is expressly understood that the BIM files are being issued only as supplemental information for convenience to the Contractor.

ADW utilizes electronic machine-readable files that are compatible with Autodesk REVIT. The files furnished, if so requested, will be exported to .RVT format. ADW makes no representation as to the compatibility of these files with your hardware and/or software. The Contractor shall understand that the automated conversion of information and data from the system and format used by ADW and all of the design professionals on this Project ("Design Team") to an alternate system or format cannot be accomplished without the introduction of inaccuracies, anomalies and errors, whether inadvertently or otherwise. As a result, no representations or warranties, whether expressed or implied, as to the accuracy of the BIM files transferred are made herein. In the event project documentation provided in electronic machine-readable format is so converted, the Contractor agrees to assume all risks associated therewith and, to the fullest extent permitted by law, to hold harmless and indemnify ADW from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney's fees, arising therefrom in connection therewith. As the accuracy of the BIM files cannot be warranted or guaranteed, it is issued as supplemental information only and must be read in conjunction the contract documents. These electronic or machine-readable files are not Contract Documents. Significant differences may exist between these electronic machine-readable files and corresponding hard copy Contract Documents due to addenda, change orders or other revisions. ADW makes no representation regarding the accuracy or completeness of the electronic or machine-readable files you receive. In the event that a conflict arises between the signed Contract Documents prepared by ADW and the electronic machine-readable files, signed Contract Documents shall govern. The Contractor is responsible for determining if any conflict exists. By use of these files, the Contractor is not relieved of his duty to fully comply with the Contract Documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate the Work with that of other Contractors.

Data contained on these electronic machine-readable files is part of ADW's instruments of service and shall not be used by the Contractor or anyone else receiving this data through and from the Contractor for any purpose other than as a convenience pertaining to the specific project as indicated on the files furnished. The BIM files are not to be used for fabrication or construction of any kind. The Contractor recognizes that changes or modifications to ADW's instruments of professional service introduced by anyone other than ADW may result in adverse consequences, which ADW can neither predict nor control. Therefore, and in consideration of ADW's agreement to deliver its instruments of professional service in an electronic machine-readable format, the Contractor agrees, to the fullest extent permitted by law, to hold harmless and indemnify ADW from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney's fees, arising out of or in any way connected with the modification, misinterpretation, misuse, or reuse by others of the electronic machine-readable information and data provided by ADW under this agreement. The foregoing indemnification applies, without limitation, to any use of the project documentation on other projects, for additions, or for completion by others, excepting only such use as may be authorized, in writing, by ADW.

The BIM files provided by the Design Team under the terms of this Agreement are the proprietary information and property of the Design Team, who shall maintain all copyright and intellectual property rights in the BIM files. All BIM files shall be treated as confidential and are not to be disclosed to or shared with others without the Design Team's written consent. The use of the BIM files for any other purpose other than for supplemental information for convenience during the construction process is prohibited.

Under no circumstances shall delivery of the electronic machine-readable files for use by The Contractor be deemed a sale by ADW and ADW makes no warranties, either express or implied, of merchantability and fitness for any particular purpose. In no event shall ADW Architects be liable for any loss of profit or any consequential damages. Usage by any parties of the data contained in the electronic machine-readable files released shall constitute agreement to these terms. However, for record keeping we request that you sign this agreement, copy it for your files and return the signed copy to us along with requested files.

The cost of providing this service will be \$1,500 per BIM model

Provide a check payable to:

**ADW Architects, PA
Six Coliseum Centre
2815 Coliseum Centre, Suite 500
Charlotte, North Carolina 28217**

Acknowledged and accepted by:

Company

Authorized Representative

Date

SECTION 01 40 00 - QUALITY REQUIREMENTS

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. 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 01 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
 - 2. Review Divisions 02 through 49 sections for specific test and inspection requirements.

1.3 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.
- D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.4 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.

1.5 SUBMITTALS

- A. 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.
- B. 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.
- C. Not later than 30 calendar days after the Notice to Proceed date, the contractor shall furnish to the Architect for review a complete list of all subcontractors and all material and equipment to be used in the Project showing the manufacturer, supplier, trade name, and model number of each. Where the specification allows a choice, the list shall indicate the Contractor's choice. This list shall follow the sequence of the sections of the specifications.

1.6 QUALITY ASSURANCE

- A. 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 are similar to those indicated for this Project in material, design, and extent.
- B. 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.
- C. 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.
- D. 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.
- E. 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.

- F. **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.
- G. **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 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.

1.7 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.
 - 2. 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. **Special Tests and Inspections:** Owner will engage a 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 reinspect corrected work.
- C. **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.
- D. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.
- E. **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. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 6. Security and protection for samples and for testing and inspecting equipment at Project site.
- F. 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.
 2. Notify testing agency and Architect at least 48 hours in advance of time required to perform testing services.
 3. Notify testing agency and Architect at least 72 hours in advance to inspect concrete reinforcing placement prior to pouring concrete or grouting masonry.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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 01 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 - REFERENCES

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 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," "approved," "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. "Installer": Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- J. "Experienced": When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

- K. "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.

1.3 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. Abbreviations and Acronyms for 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 site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl1@dom1

ADAAG	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-5434
CFR	Code of Federal Regulations Available from Government Printing Office www.access.gpo.gov/nara/cfr	(888) 293-6498 (202) 512-1530
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from National Institute of Building Sciences www.nibs.org	(202) 289-7800

1.4 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 site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl2@dom1

AA	Aluminum Association, Inc. (The) www.aluminum.org	(202) 862-5100
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AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
ACI	American Concrete Institute/ACI International www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AHA	American Hardboard Association www.ahardbd.org	(847) 934-8800
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.e-architect.com	(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 www.aitc-glulam.org	(303) 792-9559
ALCA	Associated Landscape Contractors of America www.alca.org	(800) 395-2522 (703) 736-9666
ALSC	American Lumber Standard Committee	(301) 972-1700
ANLA	American Nursery & Landscape Association www.anla.org	(202) 789-2900
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(941) 454-6989
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASTM	American Society for Testing and Materials www.astm.org	(610) 832-9585
AWI	Architectural Woodwork Institute www.awinet.org	(800) 449-8811 (703) 733-0600
AWPA	American Wood-Preservers' Association www.awpa.com	(817) 326-6300
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The)	(703) 620-0010

	www.bia.org	
CCFSS	Center for Cold-Formed Steel Structures www.umn.edu/~ccfss	(573) 341-4471
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
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	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPA	Composite Panel Association (Formerly: National Particleboard Association) www.pbmdf.com	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
EIMA	EIFS Industry Members Association www.eifsfacts.com	(800) 294-3462 (770) 968-7945
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
FMG (FM)	FM Global (Formerly: FM - Factory Mutual System) www.fmgglobal.com	(401) 275-3000
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANNA	Glass Association of North America (Formerly: FGMA - Flat Glass Marketing Association) www.glasswebsite.com/ganna	(785) 271-0208
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
IGCC	Insulating Glass Certification Council www.igcc.org	(315) 646-2234
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LGSI	Light Gage Structural Institute www.loseke.com	(972) 370-0967
LMA	Laminating Materials Association (Formerly: ALA - American Laminators Association) www.lma.org	(201) 664-2700
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(312) 201-0193
MFMA	Metal Framing Manufacturers Association	(312) 644-6610
MIA	Marble Institute of America www.marble-institute.com	(614) 228-6194
NAAMM	National Association of Architectural Metal Manufacturers	(312) 332-0405

NAIMA	www.naamm.org North American Insulation Manufacturers Association (The) www.naima.org	(703) 684-0084
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(414) 248-9094
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(303) 697-8441
NFPA	National Fire Protection Association www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-6372
NGA	National Glass Association www.glass.org	(703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NPA	National Particleboard Association (See CPA)	
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
NSA	National Stone Association www.aggregates.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo and Mosaic Association, Inc. www.ntma.com	(800) 323-9736 (703) 779-1022
NWWDA	National Wood Window and Door Association (See WDMA)	
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting and Decorating Contractors of America www.pdca.com	(800) 332-7322 (703) 359-0826
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (508) 230-3516
RCSC	Research Council on Structural Connections www.boltcouncil.org	(800) 644-2400 (312) 670-2400
RMA	Rubber Manufacturers Association www.rma.org	(800) 220-7620 (202) 682-4800
SDI	Steel Deck Institute www.sdi.org	(847) 462-1930
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SGCC	Safety Glazing Certification Council www.sgcc.org	(315) 646-2234
SIGMA	Sealed Insulating Glass Manufacturers Association www.sigmaonline.org/sigma	(312) 644-6610
SJI	Steel Joist Institute	(843) 626-1995

SMACNA	www.steeljoist.org Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) www.sprayfoam.org	(800) 523-6154
SPI	The Society of the Plastics Industry www.plasticsindustry.org	(202) 974-5200
SPIB	Southern Pine Inspection Bureau (The) www.spib.org	(850) 434-2611
SPRI	SPRI (Single Ply Roofing Institute) www.spri.org	(781) 444-0242
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSMA	Steel Stud Manufacturers Association (Formerly: ML/SFA - Metal Lath/Steel Framing Association) www.ssma.com	(312) 456-5590
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(800) 837-8303 (412) 281-2331
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453
TPI	Truss Plate Institute	(608) 833-5900
UL	Underwriters Laboratories Inc. www.ul.com	(800) 704-4050 (847) 272-8800
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(800) 223-2301 (847) 299-5200
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

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 site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl3		
BOCA	BOCA International, Inc. www.bocai.org	(708) 799-2300
IAPMO	International Association of Plumbing and Mechanical Officials (The) www.iapmo.org	(909) 595-8449
ICBO	International Conference of Building Officials www.icbo.org	(800) 284-4406 (562) 699-0541
ICC	International Code Council (Formerly: CABO - Council of American Building Officials) www.intlcode.org	(703) 931-4533
SBCCI	Southern Building Code Congress International, Inc. www.sbcci.org	(205) 591-1853

- 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 site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl4@dom1

CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-0990
EPA	Environmental Protection Agency www.epa.gov	(202) 260-2090
OSHA	Occupational Safety & Health Administration www.osha.gov	(202) 693-1999
USPS	Postal Service www.usps.com	(202) 268-2000

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 45 29 - TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 SCOPE:

- A. The Owner will employ and pay for the services of an independent testing laboratory to perform specified testing.
 - 1. Contractor shall cooperate with laboratory to facilitate the execution of its required services.
 - 2. The Contractor shall be fully responsible for seeing that all materials meet the Project requirements. Failure of the Architect or testing laboratory to detect defective work, workmanship, or materials shall in no way prevent rejection and the Contractor taking approved corrective action when such defects are discovered. The Architect shall not be obligated to make final acceptance.

1.02 LABORATORY DUTIES:

- A. Cooperate with Architect and Contractor; provide qualified personnel.
- B. Perform specified inspections, sampling and testing of materials and methods of construction. Comply with specified standards and ascertain compliance of materials with requirements of Contract Documents.
- C. Promptly notify Architect and Contractor of observed irregularities or deficiencies of the Work or products.
 - 1. Promptly submit written report of each test and inspection; one copy each to the Architect, Owner, Contractor, and one copy to Record Documents file. Each report shall, at a minimum, include:
 - a. Date issued.
 - b. Project title and number.
 - c. Testing laboratory name, address and telephone number.
 - d. Name and signature of laboratory inspector.
 - e. Date and time of sampling or inspection.
 - f. Record of temperature and weather conditions.
 - g. Date of test.
 - h. Identification of product and specification section.
 - i. Location of sample or test in the Project.
 - j. Type of inspection or test.
 - k. Results of tests and compliance with Contract Documents.
 - l. Interpretations of test results.
 - 2. Perform additional tests as required by the Architect or the Owner.

1.03 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY:

- A. Laboratory
 - 1. Release, revoke, alter or enlarge on requirements of the Contract Documents.
 - 2. Approve or accept any portion of the Work.
 - 3. Perform any duties of the Contractor.
 - 4. Give instruction to the Contractor's workman in the field. All contact shall be with the Architect (or his representative) and the Contractor's Project Manager.

1.04 CONTRACTOR'S RESPONSIBILITIES:

- A. Cooperate with laboratory personnel, provide access to Work, to manufacturer's operations.
- B. Secure and deliver to the laboratory, adequate quantities of representational samples of materials proposed to be used and which require testing.
- C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other materials mixes which require control by the testing laboratory.
- D. Furnish copies of products test reports as required.
- E. Furnish incidental labor and facilities:
 - 1. To provide access to Work to be tested.
 - 2. To obtain and handle samples at the Project site or at the source of the project to be tested.
 - 3. To facilitate inspections and tests.
 - 4. For storage and curing of test samples.
- F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests. When tests or inspections cannot be performed after such notice, reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence. The contractor shall reimburse the owner if an inspection fails for a second time, the second test and any subsequent tests shall be paid for by the GC.
- G. The Contractor may for his own convenience, employ and pay for a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing. This shall be done with the understanding that:
 - 1. The additional testing shall be accomplished in accordance with the General Conditions;
 - 2. That the finds of such additional inspections, samplings, and testing shall in no way be binding upon the Owner and the Architect;
 - 3. That any such additional inspections, samplings and testing shall be performed at no additional cost to the Owner.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 01 45 29

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 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.

1.2 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. Water service and distribution.
 - 2. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
 - 3. Electric power service.
 - 4. Lighting.
 - 5. Telephone service.
- C. Support facilities include, but are not limited to, the following:
 - 1. Temporary roads and paving.
 - 2. Dewatering facilities and drains.
 - 3. Waste disposal facilities.
 - 5. Field offices.
- 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. Site enclosure fence.
 - 5. Security enclosure and lockup.
 - 6. Barricades, warning signs, and lights.

1.4 USE CHARGES

- A. General: Cost or use charges for temporary facilities are not chargeable to Owner or Civil Engineer 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. Engineer.
 - 2. Testing agencies.
 - 3. Personnel of authorities having jurisdiction.
- B. Water Service: Pay water service use charges, whether metered or otherwise, for water used by all entities engaged in construction activities at Project site.
- C. Electric Power Service: Pay electric power service use charges, whether metered or otherwise, for electricity used by all entities engaged in construction activities at Project site.

1.5 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.

1.6 PROJECT CONDITIONS

- A. 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

2.1 MATERIALS

- A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Civil Engineer. Provide materials suitable for use intended.

2.2 EQUIPMENT

- A. General: Provide equipment suitable for use intended.
- B. 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.

- C. 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.

PART 3 - EXECUTION

3.1 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.

3.2 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: Use of Owner's existing water service facilities will be permitted, as long as facilities are individually metered, cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
 - 1. Provide rubber hoses as necessary to serve Project site.
 - 2. Provide temporary hydrant meter and backflow preventer as required by jurisdictional authority.
- 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.
 - 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.
- D. Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include overload-protected disconnecting means, and automatic ground-fault interrupters.
 - 1. Connect temporary service to Owner's existing power source.

- E. Electric Distribution: Provide 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.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Locate storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 - 2. 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. 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.

3.4 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. 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.

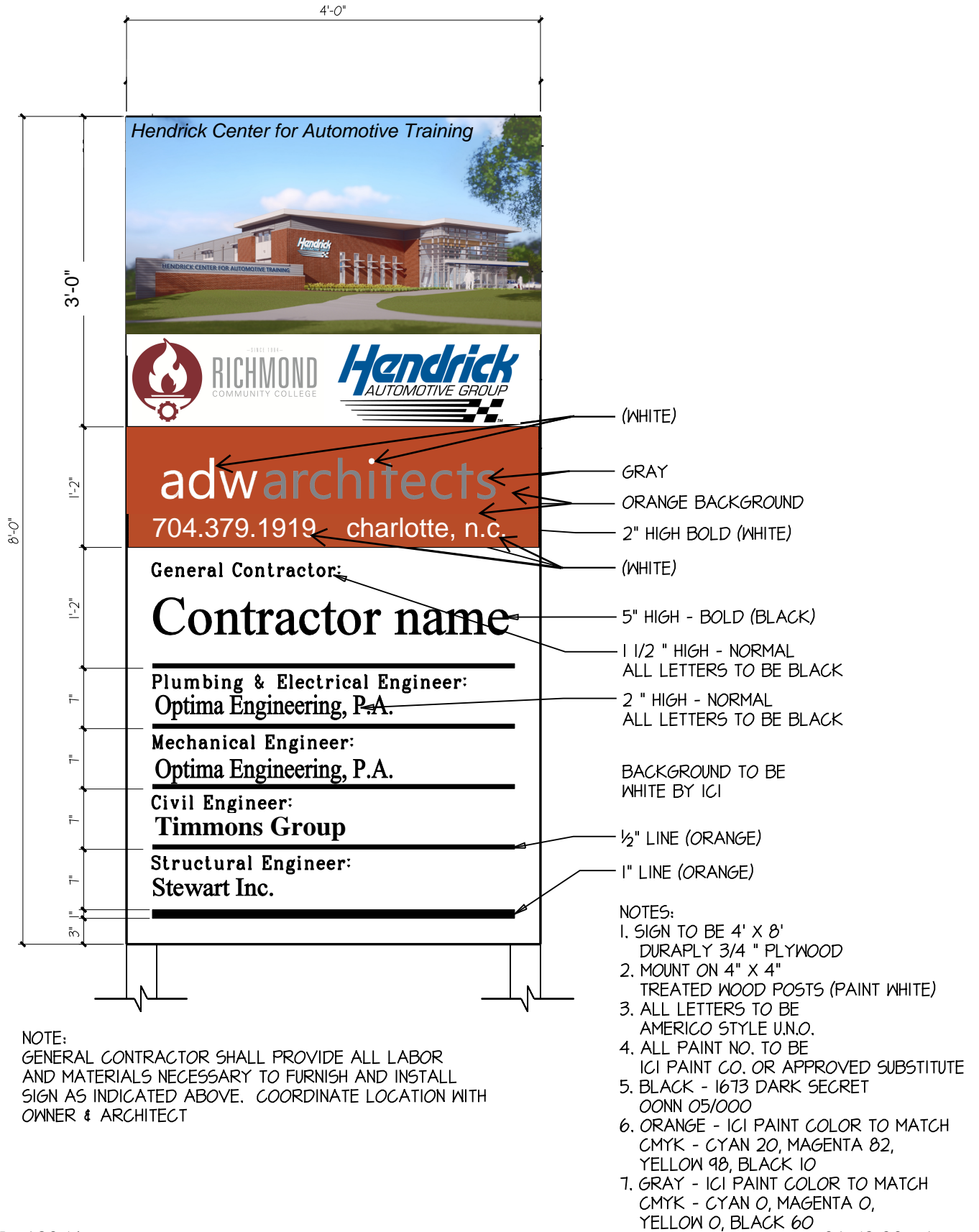
3.5 OPERATION, TERMINATION, AND REMOVAL

- 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.
- C. 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.

2. 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 58 00 - PROJECT IDENTIFICATION



NOTE:
GENERAL CONTRACTOR SHALL PROVIDE ALL LABOR
AND MATERIALS NECESSARY TO FURNISH AND INSTALL
SIGN AS INDICATED ABOVE. COORDINATE LOCATION WITH
OWNER & ARCHITECT

Division 02 – Existing Conditions

SECTION 02 41 13 - SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

- A. This Section includes the following:
 1. Demolition and removal of existing asphalt and/or concrete pavement, concrete and/or asphalt walks, curbs and gutters, and other exterior site items indicated or not indicated which interfere with the Work.
 2. Removal and/or relocation of existing underground utilities and vaults.
 3. Removal and disposal of existing sanitary sewer pipe, water pipe, storm drainage pipe and appurtenances indicated. Filling of existing pipes to be abandoned in place.
 4. Removal and relocation of existing light or power poles.

1.3 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
- B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.
- C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
- D. Existing to Remain: Protect items indicated to remain against damage and soiling. When permitted by the Architect, items may be removed to a suitable, protected storage location and then cleaned and reinstalled in their original locations.

1.4 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, remove demolished materials from the site with further disposition at the Contractor's option.
- B. Storage or sale of removed items or materials on-site will not be permitted.
- C. Historical items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Owner, which may be encountered, remain the Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the Work.
- B. Record drawings at Project closeout.
 - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.
- C. Proposed dust-control measures.
- D. Schedule of selective demolition activities indicating the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - 2. Interruption of utility services.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
 - 5. Inventory of items to be removed and salvaged or turned over to Owner.
- E. Landfill records indicating receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: All work shall comply with Federal, State and Local laws and regulations concerning hauling and disposal of demolition debris.
- B. Notify the proper agencies prior to the start of work and obtain all necessary permits for this work.

1.7 PROJECT CONDITIONS

- A. Owner assumes no responsibility for actual condition of items or structures to be demolished. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner to the extent practical. However, minor variations may occur due to Owner's removal and salvage operations prior to the start of demolition work.
- B. The location of existing underground utilities indicated is approximate only. Field locate all existing underground utilities in the area of work, regardless of whether or not they are indicated. Call "NC one call" at 1-800-632-4949 prior to the start of demolition work for assistance in the location of existing underground utilities.
- C. Should charted, uncharted or incorrectly charted utilities be encountered during demolition, contact the Architect immediately for instructions. Cooperate with Owner and utility companies to keep services and facilities in operation.
- D. Do not interrupt existing utilities serving facilities occupied and used by the Owner and others, except when permitted in writing by the Owner. Provide acceptable temporary utility service as required to maintain Owner's operations.

1.8 SCHEDULING

- A. Owner will occupy portions of the building immediately adjacent to the Work. Conduct selective demolition so that the Owner's operations will not be disrupted. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.
- B. Arrange selective demolition schedule so as not to interfere with Owner's on-site operations.
- C. Notify and coordinate any required relocation and/or removal of existing underground utilities, poles, meters or other above ground appurtenances with the appropriate utility company (i.e. power, telephone, cable and natural gas/propane) prior to the start of selective demolition work.

1.9 USE OF EXPLOSIVES

- A. Do not use explosives to perform selective site demolition work.

PART 2 - PRODUCTS

- 5. (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Field locate all existing underground utilities in the area of work, regardless of whether or not they are indicated.
- B. Provide a scale drawing with the location of the uncharted or incorrectly charted utilities for use by the Architect in preparing additional direction.
- C. Verify that utilities indicated as removed, abandoned and/or relocated have been disconnected and capped.
- D. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- E. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged and turned over to the Owner.

3.2 PROTECTION OF PERSONS AND PROPERTY

- A. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- B. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, 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 governing regulations.
- C. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.

1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
 2. Protect existing site improvements, appurtenances, and landscaping to remain.
- D. Barricade areas of demolition occurring as part of this work, and post with warning lights as required by authorities having jurisdiction.
- E. Protect structures, buildings, utilities, walks, pavements, existing vegetation and other facilities to remain from damage caused by settlement, lateral movement, undermining, washout and other hazards created by demolition operations.

3.3 DEMOLITION OF EXISTING FACILITIES AND POLLUTION CONTROLS

- A. Perform all work in accordance with the requirements of the latest edition of the North Carolina Erosion and Sediment Control Planning and Design Manual and those of the local Erosion Control official.
- B. Clean adjacent structures and improvements of dust, dirt, and debris caused by the Work. Return adjacent areas to condition existing before start of selective demolition.
- C. Light Poles

3.4 DISPOSAL OF DEMOLISHED MATERIALS

- A. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Do not burn demolished materials or debris.
- C. Transport and legally dispose of demolished materials off of Owner's property.

3.5 CLEANUP AND REPAIR

- A. Upon completion of demolition work remove all tools, equipment and demolition materials from site. Remove demolition work area protection and leave areas clean.
- B. Repair any demolition performed in excess of that required. Return elements of construction and surfaces to remain to the condition existing prior to the start of construction. Repair adjacent construction or surfaces soiled or damaged by demolition work.

END OF SECTION 02 41 13

Division 03 – Concrete

SECTION 031000 - CONCRETE FORMING AND 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. Form-facing material for cast-in-place concrete.
- 2. Form liners.
- 3. Shoring, bracing, and anchoring.

- B. Related Requirements:

- 1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.

1.3 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction, movement, contraction, and isolation joints
- c. Forms and form-removal limitations.
- d. Shoring and reshoring procedures.
- e. Anchor rod and anchorage device installation tolerances.

1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following:
 - 1. Exposed surface form-facing material.
 - 2. Concealed surface form-facing material.
 - 3. Forms for cylindrical columns.
 - 4. Form liners.
 - 5. Form ties.
 - 6. Waterstops.
 - 7. Form-release agent.

- B. Sustainable Design Submittals:
 - 1. Environmental Product Declaration: For each product.
 - 2. Health Product Declaration: For each product.
 - 3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - 4. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

- C. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
 - 2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
 - a. Location of construction joints is subject to approval of the Architect.
 - 3. Indicate location of waterstops.
 - 4. Indicate form liner layout and form line termination details.
 - 5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC308.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Form Liners: Store form liners under cover to protect from sunlight.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
 - 1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
 - 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
- B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
 - 1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:
 - a. Wind Loads: As indicated on Drawings.
 - 1) Horizontal Deflection Limit: Not more than 1/240 of the wall height.

2.2 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
 - 1. Provide continuous, true, and smooth concrete surfaces.
 - 2. Furnish in largest practicable sizes to minimize number of joints.
 - 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
 - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - 1) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 2) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
 - 1. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class.
 - 1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Form Liners:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Architectural Polymers, Inc.
 - b. Fitzgerald Formliners.
 - c. Sika Corporation.
 - d. Spec Formliners, Inc.
 - 2. Face Pattern: Smooth.

2.3 WATERSTOPS

- A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513, for embedding in concrete to prevent passage of fluids through joints, with factory fabricated corners, intersections, and directional changes.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Williams Products, Inc.
 - 2. Profile: Flat dumbbell with center bulb.
 - 3. Dimensions: 4 inches by 3/16 inch thick; nontapered.
- B. Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BoMetals, Inc.
 - b. Sika Corporation.
 - c. Vinylex Waterstop & Accessories.
 - 2. Profile: Flat dumbbell with center bulb.
 - 3. Dimensions: 4 inches by 3/16 inch thick; nontapered.

- C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. CETCO, a Minerals Technologies company.
 - c. Concrete Sealants Inc.
 - d. Sika Corporation.
- D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adeka Corporation.
 - b. CETCO, a Minerals Technologies company.
 - c. GCP Applied Technologies Inc.
 - d. Sika Corporation.

2.4 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034-inch- thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
 1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
 2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
 3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
 1. Minimize joints.
 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
 1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 1. Provide and secure units to support screed strips
 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.

- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
 - K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
 - L. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 6. Space vertical joints in walls as indicated on Drawings.
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
 - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
 - N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
 - O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
 - P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- 3.2 INSTALLATION OF EMBEDDED ITEMS
- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.
1. Install in longest lengths practicable.
 2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
 3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
 4. Secure waterstops in correct position at 12 inches on center.
 5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.
 - a. Miter corners, intersections, and directional changes in waterstops.
 - b. Align center bulbs.
 6. Clean waterstops immediately prior to placement of concrete.
 7. Support and protect exposed waterstops during progress of the Work.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.
1. Install in longest lengths practicable.
 2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
 3. Protect exposed waterstops during progress of the Work.

3.4 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
1. Align and secure joints to avoid offsets.
 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.5 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

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. Steel reinforcement bars.
- 2. Welded-wire reinforcement.

- B. Related Requirements:

- 1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
- 2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
- 3. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction contraction and isolation joints.
- c. Steel-reinforcement installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:

- 1. Each type of steel reinforcement.
- 2. Bar supports.
- 3. Mechanical splice couplers.

- B. Sustainable Design Submittals:

- 1. Environmental Product Declaration: For each product.

2. Health Product Declaration: For each product.
 3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
- C. Shop Drawings: Comply with ACI SP-066:
1. Include placing drawings that detail fabrication, bending, and placement.
 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
1. Location of construction joints is subject to approval of the Architect.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M
- B. Material Test Reports: For the following, from a qualified testing agency:
1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
 2. Mechanical splice couplers.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- C. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Mechanical Splice Couplers: ACI 318 Type 1, same material of reinforcing bar being spliced; tension-compression type.
- D. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
 - 1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
 2. Stagger splices in accordance with ACI 318.
 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths.
1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.
 2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire.
 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 4. Lace overlaps with wire.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement.

2. Continue reinforcement across construction joints unless otherwise indicated.
 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel-reinforcement placement.
 2. Steel-reinforcement mechanical splice couplers.
 3. Steel-reinforcement welding.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

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. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

- B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
 - 2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
 - 3. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
 - 4. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with fly ash.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - 2. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction joints, control joints, isolation joints, and joint-filler strips.
- c. Semirigid joint fillers.
- d. Vapor-retarder installation.
- e. Anchor rod and anchorage device installation tolerances.
- f. Cold and hot weather concreting procedures.
- g. Concrete finishes and finishing.
- h. Curing procedures.
- i. Forms and form-removal limitations.
- j. Shoring and reshoring procedures.
- k. Methods for achieving specified floor and slab flatness and levelness.
- l. Floor and slab flatness and levelness measurements.
- m. Concrete repair procedures.
- n. Concrete protection.
- o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
- p. Protection of field cured field test cylinders.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
5. Vapor retarders.
6. Floor and slab treatments.
7. Liquid floor treatments.
8. Curing materials.
9. Joint fillers.
10. Repair materials.

B. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
4. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.

2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Engineer of Record.

E. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Semirigid joint filler.
9. Joint-filler strips.

10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Aggregates.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.

5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
 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

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Regional Materials: Concrete shall be manufactured within 100 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- B. Source Limitations:
1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 3. Obtain aggregate from single source.
 4. Obtain each type of admixture from single source from single manufacturer.
- C. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
 2. Fly Ash: ASTM C618, Class C or F.
- D. Normal-Weight Aggregates: ASTM C33/C33M, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
1. Alkali-Silica Reaction: Comply with one of the following:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
 - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance

with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- E. Lightweight Aggregate: ASTM C330/C330M, 3/4-inch nominal maximum aggregate size.
- F. Air-Entraining Admixture: ASTM C260/C260M.
- G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- H. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Barrier-Bac; Intoplast Group.
 - b. ISI Building Products.
 - c. Poly-America, L.P.
 - d. Reef Industries, Inc.
 - e. Stego Industries, LLC.
 - f. Tex-Trude.
 - g. W.R. Meadows, Inc.

2.4 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. ChemMasters, Inc.

- c. ChemTec International.
 - d. Concrete Sealers USA.
 - e. Dayton Superior.
 - f. Euclid Chemical Company (The); an RPM company.
 - g. Kaufman Products, Inc.
 - h. Laticrete International, Inc.
 - i. Nox-Crete Products Group.
 - j. PROSOCO, Inc.
 - k. SpecChem, LLC.
 - l. US SPEC, Division of US MIX Company.
 - m. Vexcon Chemicals Inc.
 - n. V-Seal Concrete Sealers & Specialty Coatings.
 - o. W.R. Meadows, Inc.
2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. Bon Tool Co.
 - c. ChemMasters, Inc.
 - d. Dayton Superior.
 - e. Euclid Chemical Company (The); an RPM company.
 - f. Kaufman Products, Inc.
 - g. Lambert Corporation.
 - h. Laticrete International, Inc.
 - i. Metalcrete Industries.
 - j. Nox-Crete Products Group.
 - k. Sika Corporation.
 - l. SpecChem, LLC.
 - m. TK Products.
 - n. Vexcon Chemicals Inc.
 - o. W.R. Meadows, Inc.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 1. Color:
 - a. Ambient Temperature Below 50 deg F: Black.
 - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
 - c. Ambient Temperature Above 85 deg F: White.

- C. Water: Potable or complying with ASTM C1602/C1602M.
- D. Clear, Waterborne, Membrane-Forming, Non-dissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anti-Hydro International, Inc.
 - b. BASF Corporation.
 - c. ChemMasters, Inc.
 - d. Dayton Superior.
 - e. Euclid Chemical Company (The); an RPM company.
 - f. Kaufman Products, Inc.
 - g. Lambert Corporation.
 - h. Laticrete International, Inc.
 - i. Metalcrete Industries.
 - j. Nox-Crete Products Group.
 - k. SpecChem, LLC.
 - l. TK Products.
 - m. Vexcon Chemicals Inc.
 - n. W.R. Meadows, Inc.
- E. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ChemMasters, Inc.
 - b. Concrete Sealers USA.
 - c. Dayton Superior.
 - d. Euclid Chemical Company (The); an RPM company.
 - e. Kaufman Products, Inc.
 - f. Lambert Corporation.
 - g. Laticrete International, Inc.
 - h. Metalcrete Industries.
 - i. Nox-Crete Products Group.
 - j. Right Pointe.
 - k. SpecChem, LLC.
 - l. TK Products.
 - m. Vexcon Chemicals Inc.
 - n. W.R. Meadows, Inc.
 - 2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.7 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4,100 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5,000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.8 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
 - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for parking structure slabs, and concrete with a w/cm below 0.50.

2.9 CONCRETE MIXTURES

- A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 3,000 psi at 28 days.
 3. Maximum w/cm: 0.55.
 4. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 5. Air Content: 2.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4 inch nominal maximum aggregate size.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- B. Class B: Normal-weight concrete used for foundation walls.
1. Exposure Class: ACI 318 F1, S0, W0, C0.
 2. Minimum Compressive Strength: 4,500 psi at 28 days.
 3. Maximum w/cm: 0.45.
 4. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 5. Air Content:
 - a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- C. Class C: Normal-weight concrete used for interior slabs-on-ground.
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 3,000 psi at 28 days.
 3. Maximum w/cm: 0.55.
 4. Minimum Cementitious Materials Content: 540 lb/cu. yd.
 5. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 6. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- D. Class D: Normal-weight concrete used for interior suspended slabs.
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 4,000 psi at 28 days.
 3. Maximum w/cm: 0.55.
 4. Minimum Cementitious Materials Content: 540 lb/cu. yd.
 5. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 6. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 7. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- E. Class E: Structural lightweight concrete used for interior suspended slabs and concrete toppings/pads over suspended slabs.
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 4,000 psi at 28 days.
 3. Calculated Equilibrium Unit Weight: 118 lb/cu. ft., plus or minus 3 lb/cu. ft. as determined by ASTM C567/C567M.
 4. Slump Limit: 3 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 5. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- F. Class F: Normal-weight concrete used for exterior slabs-on-ground, concrete toppings/pads over slabs-on-ground, exterior pads, and balcony topping slabs.
1. Exposure Class: ACI 318 F2, S0, W1, C0.
 2. Minimum Compressive Strength: 4,500 psi at 28 days.
 3. Maximum w/cm: 0.45.
 4. Minimum Cementitious Materials Content: 540 lb/cu. yd.
 5. Slump Limit: 4 inches, plus or minus 1 inch.
 6. Air Content:
 - a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 7. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- G. Class G: Normal-weight concrete used for building frame members.
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 5,000 psi at 28 days.
 3. Maximum w/cm: 0.45.

4. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 5. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- H. Class H: Normal-weight concrete used for building walls.
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 4,000 psi at 28 days.
 3. Maximum w/cm: 0.45.
 4. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 5. Air Content: 2.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4 inch nominal maximum aggregate size.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- I. Class I: Normal-weight concrete used for interior metal pan stairs and landings:
1. Exposure Class: ACI 318 F0, S0, W0, C0.
 2. Minimum Compressive Strength: 2,500 psi at 28 days.
 3. Maximum w/cm: 0.65.
 4. Minimum Cementitious Materials Content: 470 lb/cu. yd.
 5. Maximum Size Aggregate: 1/2 inch.
 6. Slump Limit: 2.5 inches, plus or minus 1.5 inches.
 7. Air Content: 0 percent, plus or minus 0.5 percent at point of delivery.
 8. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
 9. Retarding Admixture: Not allowed.
 10. Accelerating Admixture: Not allowed.
- J. Class J: Normal-weight concrete used for exterior retaining walls.
1. Exposure Class: ACI 318 F2, S0, W0, C0.
 2. Minimum Compressive Strength: 4,500 psi at 28 days.
 3. Maximum w/cm: 0.45.
 4. Slump Limit: 4 inches, plus or minus 1 inch, before adding high-range water-reducing or plasticizing admixtures at the Project site (8 inches, plus or minus 1 inch thereafter).
 5. Air Content:
 - a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 - 1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
 - 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 - 1. Daily access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
 - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by the Engineer of Record.
 2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
 3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
 1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Engineer of Record and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer of Record in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
 2. Deposit concrete to avoid segregation.
 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

- a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 3. Maintain reinforcement in position on chairs during concrete placement.
 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 5. Level concrete, cut high areas, and fill low areas.
 6. Slope surfaces uniformly to drains where required.
 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
 8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117 Class D.
 - e. Apply to concrete surfaces not exposed to public view.
2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/4 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class B.
 - e. Locations: Apply to concrete surfaces as indicated.
3. ACI 301 Surface Finish SF-3.0:
 - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
 - b. Remove projections larger than 1/8 inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 Class A.

- e. Locations: Apply to concrete surfaces as indicated.
- B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:
- 1. Smooth-Rubbed Finish:
 - a. Perform no later than one day after form removal.
 - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
 - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
 - d. Maintain required patterns or variances as shown on Drawings or to match field sample panels.
 - 2. Grout-Cleaned Rubbed Finish:
 - a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
 - b. Do not clean concrete surfaces as Work progresses.
 - c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
 - d. Wet concrete surfaces.
 - e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
 - f. Maintain required patterns or variances as shown on Drawings or to match field sample panels.
 - 3. Cork-Floated Finish:
 - a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
 - b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
 - c. Wet concrete surfaces.
 - d. Compress grout into voids by grinding surface.
 - e. In a swirling motion, finish surface with a cork float.
 - f. Maintain required patterns or variances as shown on Drawings or to match field sample panels.
 - 4. Scrubbed Finish: After concrete has achieved a compressive strength of from 1,000 to 1,500 psi, apply scrubbed finish.
 - a. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed.
 - b. Rinse scrubbed surfaces with clean water.
 - c. Maintain continuity of finish on each surface or area of Work.
 - d. Remove only enough concrete mortar from surfaces to match field sample panels.

C. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings and to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 (ACI A117M) tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

a. Slabs on Ground:

- 1) Specified overall values of flatness, F_F 35; and of levelness, F_L 25; with minimum local values of flatness, F_F 24; and of levelness, F_L 17.
- b. Suspended Slabs:
 - 1) Specified overall values of flatness, F_F 35; and of levelness, F_L 20; with minimum local values of flatness, F_F 24; and of levelness, F_L 15. Levelness requirements may be waived for slabs on metal deck.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
 1. Coordinate required final finish with Architect before application.
 2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
 2. Coordinate required final finish with Architect before application.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In:
 1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
 3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:
 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
 3. Minimum Compressive Strength: As indicated herein.
 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 substrate.
 6. Prior to pouring concrete, place and secure anchorage devices.

- a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
1. Cast-in inserts and accessories, as shown on Drawings.
 2. Reinforce interior stairs that use concrete fill for the landings and/or treads with either microsynthetic monofilament fibers (at a minimum dosage rate of 1.0 lbs/cy) or 4x4-W1.4xW1.4 welded wire fabric.
 3. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
 2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
 3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.
- B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
 2. If forms remain during curing period, moist cure after loosening forms.
 3. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.
- C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
1. Begin curing immediately after finishing concrete.
 2. Interior Concrete Floors:

- a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12-inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than seven days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

- a) Water.
 - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- d. Floors to Receive Curing Compound:
- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
 - 3) Maintain continuity of coating, and repair damage during curing period.
 - 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
- e. Floors to Receive Curing and Sealing Compound:
- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
 - 3) Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

- A. Conform to ACI 117.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than seven days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least one month.
 2. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
 1. Repair and patch defective areas when approved by Architect.
 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

- a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces:
1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 3. After concrete has cured at least 14 days, correct high areas by grinding.
 4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
 5. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
 - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.

- d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- 1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
 - 2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 - 3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.
 - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.
 - 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.
 - 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field test results.
 - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

- D. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
 5. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 6. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of four 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of two laboratory-cured specimens at seven days and three sets of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5,000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5,000 psi.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 11. Additional Tests:
 - a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer of Record.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer of Record.
 - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301, section 1.6.6.3.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.16 PROTECTION

- A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
 2. Diaper hydraulic equipment used over concrete surfaces.
 3. Prohibit vehicles from interior concrete slabs.
 4. Prohibit use of pipe-cutting machinery over concrete surfaces.
 5. Prohibit placement of steel items on concrete surfaces.
 6. Prohibit use of acids or acidic detergents over concrete surfaces.
 7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

Division 04 - Masonry

SECTION 04 20 00 - UNIT MASONRY

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 unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units.
 - 2. Decorative concrete masonry units
 - 3. Face brick.
 - 4. Building (common) brick.
 - 5. Mortar and grout.
 - 6. Reinforcing steel.
 - 7. Masonry joint reinforcement.
 - 8. Ties and anchors.
 - 9. Embedded flashing.
 - 10. Miscellaneous masonry accessories.
- B. Related Sections include the following:
 - 1. Division 07 Section "Fluid-Applied Membrane Air Barriers" for water and air barrier applied to cavity face of backup wythes of cavity walls.
 - 2. Division 07 Section "Water Repellents" for water repellents applied to unit masonry assemblies.
 - 3. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels and shelf angles for unit masonry, furnished under Division 05.
 - 2. Manufactured reglets in masonry joints for metal flashing, furnished under Division 07.
 - 3. Hollow-metal frames in unit masonry openings, furnished under Division 08.

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 - 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection: For the following:

1. Unit masonry Samples in small-scale form showing the full range of colors and textures available for each different exposed masonry unit required.
 2. Colored mortar Samples showing the full range of colors available.
- D. Samples for Verification: For the following:
1. Full-size units for each different exposed masonry unit required, showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.
 2. Colored mortar Samples for each color required, showing the full range of colors expected in the finished construction. Make samples using the same sand and mortar ingredients to be used on Project.
 3. Accessories embedded in the masonry.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- F. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
1. Each type of masonry unit required.
 - a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
 - b. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.
 2. Mortar complying with ASTM C 270
 3. Grout mixes complying with compressive strength requirements of ASTM C 476. Include description of type and proportions of grout ingredients.
- G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
 2. Each material and grade indicated for reinforcing bars.
 3. Each type and size of joint reinforcement.
 4. Each type and size of anchor, tie, and metal accessory.
- H. Job Site Testing: The general contractor shall test three masonry units from two random loads of masonry block with an independent testing facility for compliance of the aggregate materials and mix.
- 1.5 QUALITY ASSURANCE
- A. 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, through one source from a single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
- C. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

- D. Sample Panels: Before installing unit masonry, build sample panels, using materials indicated for the completed Work, to verify selections made under sample Submittals and to demonstrate aesthetic effects. Build sample panels for each type of exposed unit masonry assembly in sizes approximately 72 inches long by 48 inches high by full thickness (or as indicated on drawings).
1. Locate panels in the locations indicated or, if not indicated, as directed by Architect.
 2. Clean exposed faces of panels with masonry cleaner indicated.
 3. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
 4. Protect approved sample panels from the elements with weather-resistant membrane.
 5. Maintain sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Note approved sample panels not meeting the above requirements shall be removed and built back to quality standards.
 - b. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, unless such deviations are specifically approved by Architect in writing.
 7. Demolish and remove sample panels when directed.
- E. If control joints are not shown on drawings, it is the Contractor's responsibility to notify the Architect for placement.

1.6 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. Exposed colored masonry block and brick shall be stored on wooden pallets.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 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. Protect exposed exterior finished materials from mud and dirt splatters with sand or straw.
- B. Do not apply uniform floor or roof loads for at least 24 hours and concentrated loads for at least 3 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 coverings spread 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 and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. General: Provide shapes indicated and as follows:
1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners, unless indicated as bullnose or other special shape.
- B. Concrete Masonry Units: ASTM C 90 (latest revision) and as follows:
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
 2. Weight Classification: Light weight meeting max. 100 density.
 3. Size (Width): Manufactured to the following dimensions:
 - a. 4 inches nominal; 3-5/8 inches actual.
 - b. 6 inches nominal; 5-5/8 inches actual.
 - c. 8 inches nominal; 7-5/8 inches actual.
 - d. 12 inches nominal; 11-5/8 inches actual.
 4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
 5. Units shall be free of organic impurities that will cause rusting, staining or pop outs, and shall contain no combustible matter. The use of coal cinder aggregate/bottom ash, or similar waste products WILL NOT be allowed.
 6. Job Site Testing: Per the request of the Architect, a random sample of the concrete masonry units may be taken from the job site to be tested for compliance with the specifications.
 7. All lightweight aggregates used in the concrete units shall be expanded shale, clay or slate stalite materials, produced by the rotary Kiln process, shall conform to ASTM C331,

C330 and shall be graded to assure constant texture. Aggregates shall have a maximum absorption rate of 10%.

- C. Decorative Concrete Masonry Units: ASTM C 90 (latest revision) and as follows:
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2600 psi or greater.
 2. Weight Classification: Normal weight.
 3. Provide Type II, nonmoisture-controlled units.
 4. Size: Manufactured to dimensions indicated for non-decorative units or as indicated on drawings.
 5. Exposed faces of decorative units: description matching color, pattern, and texture of Architect's samples.
 - a. Light weight/normal weight aggregate, color integral, polished finish. No factory applied clear coatings allowed and no cement based fillers applied to the finished face.
 - 1) Adams Products Company –Echelon Masonry, Trenwyth Architectural Masonry - Trendstone
 - 2) Cemex – Polished Designer Stone
 - 3) Johnson Concrete Products – Prestige Masonry - polished
 - b. Substitutions from alternate manufactures shall be submitted 15-days before bid date.

2.2 BRICK

- A. General: Provide shapes indicated and as follows for each form of brick required:
1. Provide units without cores or frogs and with exposed surfaces finished for ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces.
- B. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
1. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
 3. Provide special shapes as indicated on drawings.
- C. Face Brick: ASTM C 216 Grade SW, Type FBS, and as follows:
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi.
 2. Initial Rate of Absorption: Less than 20 g/30 sq. in. per minute when tested per ASTM C 67.
 3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 4. Size: Manufactured to the following actual dimensions:
 - a. Modular: 3-1/2 to 3-5/8 inches wide by 2-1/4 inches high by 7-1/2 to 7-5/8 inches long.
 5. Application: Use where brick is exposed, unless otherwise indicated.
 6. Color and Texture: Dark Red Flashed Brick with Sand Finish
 7. Products: Subject to compliance with requirements, provide one of the following:
 - a. General Shale "Annapolis",
 - b. or approved Equal.

- D. Building (Common) Brick: ASTM C 62, Grade SW, and as follows:
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi.
 - 2. Size: Manufactured to the following actual dimensions:
 - a. Match size specified for face brick.

2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.
- D. Pigmented Mortar: Colored cement or cement-lime formulation.
 - 1. Color: Color as selected by Architect from manufacturer's full range of colors or as indicated on drawings.
 - 2. Location of Pigmented Mortar indicated below:
 - 1) Field Brick: Use colored mortar.
 - 3. Products:
 - a. Colored Masonry Cement (ASTM-C 91):
 - 1) Available Manufacturers:
 - a) Cemex S.A.B. de C.V.; Richcolor Masonry Cement.
 - b) Holcim (US) Inc.; Rainbow Mortamix Custom Color Masonry Cement.
 - c) Argos US; Custom Color Masonry Cement.
 - d) Giant Cement Company
 - e) Or approved equal. (submit 10-days prior to bid date)
 - b. Colored Portland Cement-Lime Mix: (Type – S)
 - 1) Available Manufacturers:
 - a) Holcim - Rainbow CLS.
 - b) Argos US; Centurion Colorbond PL.
 - c) Lehigh Portland Cement Co.; Lehigh Custom Color Portland/Lime.
 - d) Or approved equal. (submit 10-days prior to bid date)
 - E. Aggregate for Mortar: ASTM C 144; except 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. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.
 - H. Water: Potable (low chlorine content).

2.4 REINFORCING STEEL

- A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60.

2.5 MASONRY JOINT REINFORCEMENT

- A. General: ASTM A 951 and as follows:
 - 1. Hot-dip galvanized, carbon-steel wire for both interior and exterior walls.
 - 2. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
 - 3. Wire Size for Cross Rods: W2.8 or 0.188-inch diameter.
 - 4. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units where indicated.
- B. For single-wythe masonry, provide either ladder or truss type with single pair of side rods and cross rods spaced not more than 16 inches o.c.
- C. For multi-wythe masonry, provide types as follows:
 - 1. Ladder type with perpendicular cross rods spaced not more than 16 inches o.c. and 1 side rod for each face shell of hollow masonry units more than 4 inches in width, plus 1 side rod for each wythe of masonry 4 inches or less in width.
 - 2. Adjustable (2-piece) type with single pair of side rods and cross ties spaced not more than 16 inches o.c. and with separate adjustable veneer ties engaging the cross ties. Cross ties are either U-shaped with eyes or rectangular. Space side rods for embedment within each face shell of backup wythe and size adjustable ties to extend at least halfway through outer wythe but with at least 5/8-inch cover on outside face.
 - a. Use where indicated and where horizontal joints of facing wythe do not align with those of backup wythe.

2.6 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors, specified in subsequent articles, made from materials that comply with this Article, unless otherwise indicated.
- B. Hot-Dip Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60, commercial-quality, steel sheet zinc coated by hot-dip process on continuous lines before fabrication.
- D. Steel Sheet, Galvanized after Fabrication: ASTM A 366/A 366M cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153.
- E. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.7 BENT WIRE TIES

- A. General: Rectangular units with closed ends and not less than 4 inches wide. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
 - 1. Where coursing between wythes does not align, use adjustable ties composed of 2 parts; 1 with pintles, the other with eyes; with maximum misalignment of 1-1/4 inches.
- B. Wire: Fabricate from hot-dip galvanized steel wire.

2.8 ADJUSTABLE ANCHORS FOR CONNECTING TO STEEL FRAME

- A. General: Provide two-piece hot-dip galvanized steel assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. For anchorage to steel framing: provide manufacturer's standard anchors with crimped ¼"-inch-diameter wire anchor section for welding to steel and triangular-shaped section 0.1875-inch diameter sized to extend within 1 inch of masonry face

2.9 RIGID ANCHORS

- A. General: Fabricate from steel bars as follows:
 1. 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins.
 2. Finish: Hot-dip galvanized to comply with ASTM A 153.

2.10 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:
 1. Headed bolts.
 2. Nonheaded bolts, bent or straight in manner indicated.

2.11 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with Division 07 Section "Sheet Metal Flashing and Trim."
 1. Metal Drip Edges: Fabricate from stainless steel or as indicated on Drawings. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees.
 2. Metal Flashing Terminations: Fabricate from stainless steel or as indicated on Drawings. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
- B. For flashing partly exposed to the exterior, use metal flashing specified above. For flashing not exposed to the exterior, use one of the following flexible flashings, unless otherwise indicated:
 1. Stainless Steel Fabric Flashing (Asphalt Free): 304 Stainless steel core, ASTM A167, with polymer fabric laminated to one stainless steel face with non-asphalt adhesive and polyether sealant.
 - a. Products of manufacturers listed below meeting indicated standards and specified manufacturer's product data characteristics, are acceptable for use, subject to compliance with specified requirements.
 - 1) York Manufacturing, Inc.; Multi-Flash SS
 - 2) STS Coatings, Inc.; Gorilla Flash Stainless Fabric
 - 3) Illinois Products, Inc.; IPCO Stainless Steel Fabric Flashing
 - 4) TK Products, Inc.; TK TWF
- C. Solder and Sealants for Sheet Metal Flashings: As recommended by flashing manufacturer and compatible with insulations and other substrates.
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer and compatible with insulations and other substrates.

- E. Provide preformed corners and end-dams. Use minimum 26 gauge stainless steel pre-manufactured corners. Adhere and seal to flashing per manufacturers recommendations.
- F. Termination bar: Rigid PVC or stainless steel termination bar with sealant catch lip.

2.12 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 neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use the following, unless otherwise indicated:
 - 1. Mesh Weep/Vent: Provide free-draining mesh, made from polyethylene strands. At all flashing conditions, provide weep vents that are full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard to match mortar.
- E. Cavity Drainage Material: 1-inch thick, reticulated, non-absorbent mesh, made from polyethylene strands and shaped to maintain drainage at weep holes without being clogged by mortar droppings.
 - 1. Product: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following products:
 - a. Advanced Building Products Inc.; Mortar Break
 - b. Archovations, Inc.; CavClear Masonry Mat
 - c. Dayton Superior Construction, Dur-O-Wal Division; Polytite MortarStop
 - d. Mortar Net USA, Ltd.; Mortar Net

2.13 CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelating, and wetting agents.
 - 2. For masonry subject to metallic oxidation stains, use formulation consisting of a liquid blend of organic and inorganic acids, and special inhibitors.

2.14 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 integral water repellent for color integral CMU as noted in 2.1-D previously.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Type S
- C. 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) at time of placement that will completely fill spaces intended to receive grout.
 2. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
 3. Use course grout in grout spaces 2 inches or more in horizontal dimension, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
- D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
1. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

3.3 CONSTRUCTION TOLERANCES

- A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:
- B. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.
- C. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, nor 1/2 inch maximum.
- D. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.
- E. For exposed 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. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
- F. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.4 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: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
 - 2. Or as indicated on Drawings.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. 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: In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- F. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.
- G. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- H. 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. At fire-rated partitions, install firestopping in joint between top of partition and underside of structure above to comply with Division 07.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow masonry units as follows:
 1. With full mortar coverage on horizontal and vertical face shells.
 2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
 3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
- B. Lay solid brick-size 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.
 1. At cavity walls, bevel beds away from cavity, to minimize mortar protrusions into cavity. As work progresses, trowel mortar fins protruding into cavity flat against the cavity face of the brick.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.6 BONDING OF MULTI-WYTHE MASONRY

- A. Use continuous horizontal-joint reinforcement installed in horizontal mortar joints to bond wythes together. Stagger ties in alternate courses.
- B. Use bonding system indicated on Drawings.
- C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
 1. Provide continuity with masonry joint reinforcement at corners by using prefabricated "L" units as well as masonry bonding.
- D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
 1. Provide individual metal ties not more than 16 inches o.c.
 2. Provide continuity with masonry joint reinforcement by using prefabricated "T" units.
 3. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 CAVITIES

- A. **Keep cavities clean of mortar droppings and other materials during construction.**
 1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.
- B. Coat cavity face of backup wythe to comply with Division 07 Section "Fluid Applied Air Barriers"

- C. Installing Cavity-Wall Insulation: Place small dabs of adhesive spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 HORIZONTAL MASONRY JOINT REINFORCEMENT

- A. General: Provide continuous masonry joint reinforcement as indicated. 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. This reinforcement is in addition to continuous reinforcement.
 - 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.
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.9 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 - 1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
 - 2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.10 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement. If joints are not indicated, install them as per National Concrete Masonry Association (NCMA) and Brick Industry Association (BIA) recommendations.
- B. Form control joints in concrete masonry as follows:
 - 1. Install preformed control-joint gaskets designed to fit standard sash block.
 - 2. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake joint.
- C. Form expansion joints in brick made from clay or shale as follows:

1. Where indicated on drawings, build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints, if any.
 2. Form open joint of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Sealants." Keep joint free and clear of mortar.
- D. Build in horizontal, pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Sealants."
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.
- E. See quality assurance, 1.5-E, control joint placement.
- 3.11 LINTELS
- A. Install steel lintels where indicated.
- B. Provide masonry 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.
1. Provide precast lintels made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcing bars indicated or required to support loads indicated. Cure precast lintels by the same method used for concrete masonry units.
 2. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.
- 3.12 FLASHING, WEEP HOLES, AND VENTS
- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Unless otherwise indicated, place through-wall flashing on sloping bed of mortar and apply sealant under flashing. Cover flashing with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
- C. Install flashing as follows:
1. At multiwythe masonry walls, including cavity walls, extend flashing from exterior face of outer wythe of masonry, through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through inner wythe and turn flashing up approximately 2 inches, unless otherwise indicated.

2. At masonry-veneer walls, extend flashing from exterior face of veneer, through veneer, up face of sheathing at least 8 inches, and behind air-infiltration barrier or building paper. Terminate flashing with a non-corrosive termination bar per manufacturer's recommendations.
 3. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At heads and sills, extend flashing 4 inches at ends and seal into preformed end-dams per manufacturer's recommendations.
 4. Cut flashing off flush with face of wall after masonry wall construction is completed.
- D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 24 inches o.c., unless otherwise indicated.
- E. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- F. Install preformed flashing corners per manufacturer's recommendations.
- G. Install all laps of flashing with minimum 6" lap. Adhere/seal laps per manufacturer's recommendations.

3.13 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
1. Comply with requirements of ACI 530.1/ASCE 6/TM for cleanouts and for grout placement, including minimum grout space and maximum pour height

3.14 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.
- 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, polyethylene film, or waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
 5. Clean brick by the bucket-and-brush hand-cleaning method described in BIA Technical Notes No. 20, using job-mixed detergent solution.
 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.

3.15 MASONRY WASTE DISPOSAL

- A. Recycling: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including broken masonry units, waste mortar, and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of fill material for each part of masonry waste.
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. 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 waste off Owner's property.

END OF SECTION 04 20 00

Division 05 - Metals

SECTION 051200 - STRUCTURAL STEEL FRAMING

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. Structural steel.
2. Shear stud connectors.
3. Shrinkage-resistant grout.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
4. Section 099600 "High-Performance Coatings" for painting requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303 "Code of Standard Practice for Steel Buildings and Bridges".

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Shop primer.
7. Shrinkage-resistant grout.

B. Sustainable Design Submittals:

1. Environmental Product Declaration: For each product.
2. Health Product Declaration: For each product.
3. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.

D. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Fabricator, see either 1.8.A.1 or 1.8.A.2 for informational submittals needed to satisfy qualification requirements.
2. For Erector, see either 1.8.B.1 or 1.8.B.2 for informational submittals needed to satisfy qualification requirements.

B. Welding certificates, as used by either the Fabricator or the Erector.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.

2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

1.8 QUALITY CONTROL

- A. Fabricator Qualifications: The Fabricator must meet at least one of the two following requirements.
1. A Fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Accreditation Criteria 172). The Fabricator shall also have a minimum of 5 years of experience in fabricating structural steel like that indicated for this project (with a record of successful service performance) and sufficient capacity to fabricate the structural steel without delaying the work. Qualification requirements shall be satisfied by submittal of the following:
 - a. Completed project history for Fabricator, specifically focused on projects whose structural steel is like that for this project. Project history shall include Owner and Structural Engineer (as well as primary contacts) for each project listed. This qualification requirement shall be submitted as part of the bidding process.
 - b. Current AISC or IAS certification documents.
 2. A Fabricator that has an established and maintained quality control program to ensure that the work is performed in accordance with the requirements in ANSI/AISC 303 “Code of Standard Practice for Steel Buildings and Bridges”, ANSI/AISC 360 “Specification for Structural Steel Buildings”, and the Contract Documents. Program shall at a minimum address inspection of the items noted in ANSI/AISC 360 N2. The Fabricator shall also have a minimum of 5 years of experience in fabricating structural steel like that indicated for this project (with a record of successful service performance) and sufficient capacity to fabricate the structural steel without delaying the work. Qualification requirements shall be satisfied by submittal of the following:
 - a. Completed project history for Fabricator, specifically focused on projects whose structural steel is like that for this project. Project history shall include Owner and Structural Engineer (as well as primary contacts) for each project listed. This qualification requirement shall be submitted as part of the bidding process.
 - b. A written quality control manual that shall include (at a minimum) procedures for material control, inspection, and non-conformances.
 - c. Quality Control Inspector (QCI) qualifications.
- B. Erector Qualifications: The Erector must meet at least one of the two following requirements.
1. An Erector who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE. The Erector shall also have a minimum of 5 years of experience in erecting structural steel like that indicated for this project (with a record of successful service performance) and sufficient capacity to erect the structural steel without delaying the work. Qualification requirements shall be satisfied by submittal of the following:

- a. Completed project history for Erector, specifically focused on projects whose structural steel is like that for this project. Project history shall include Owner and Structural Engineer (as well as primary contacts) for each project listed. This qualification requirement shall be submitted as part of the bidding process.
 - b. Current AISC certification documents.
2. An Erector that has an established and maintained quality control program to ensure that the work is performed in accordance with the requirements in ANSI/AISC 303 “Code of Standard Practice for Steel Buildings and Bridges”, ANSI/AISC 360 “Specification for Structural Steel Buildings”, and the Contract Documents. Program shall at a minimum address inspection of the items noted in ANSI/AISC 360 N2. The Erector shall also have a minimum of 5 years of experience in erecting structural steel like that indicated for this project (with a record of successful service performance) and sufficient capacity to erect the structural steel without delaying the work. Qualification requirements shall be satisfied by submittal of the following:
- a. Completed project history for Erector, specifically focused on projects whose structural steel is like that for this project. Project history shall include Owner and Structural Engineer (as well as primary contacts) for each project listed. This qualification requirement shall be submitted as part of the bidding process.
 - b. A written quality control manual that shall include (at a minimum) procedures for material control, inspection, and non-conformances.
 - c. Quality Control Inspector (QCI) qualifications.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303 "Code of Standard Practice for Steel Buildings and Bridges".
 - 2. ANSI/AISC 360 "Specification for Structural Steel Buildings".
 - 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts".
- B. Connection Design Information:
 - 1. Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.
 - a. Use Load and Resistance Factor Design; data are given at factored-load level.
- C. Moment Connections: Type PR, partially restrained.
- D. Construction: As indicated.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M, and ASTM A572/A572M, Grade 50 as indicated.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
- E. Steel Pipe: ASTM A500/A500M, Grade B.
 - 1. Weight Class: Standard, or as indicated.
 - 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
- B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

- C. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 36, or Grades 55 and 105 as indicated on the Drawings.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A36/A36M carbon steel.
 - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- B. Headed Anchor Rods: ASTM F1554, Grade 36, or Grades 55 and 105 as indicated on the Drawings.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A36/A36M carbon steel.
 - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- C. Threaded Rods: ASTM A36/A36M.
 - 1. Nuts: ASTM A 63 heavy-hex carbon steel.
 - 2. Washers: ASTM F436, Type 1, hardened carbon steel.
 - 3. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 PRIMER

- A. Steel Primer:
 - 1. Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: MPI#134.
 - 1. Etching Cleaner: MPI#25, for galvanized steel.
 - 2. Galvanizing Repair Paint: ASTM A780/A780M.

2.6 SHRINKAGE-RESISTANT GROUT

- A. Non-metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, non-metallic aggregate grout, non-corrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1.
- F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- I. Inspection Requirements: Quality control inspection tasks shall be performed by the Fabricator's QCI in accordance with ANSI/AISC 360 N5.4 (Inspection of Welding), N5.6 (Inspection of High-Strength Bolting), and N5.7 (Inspection of Galvanized Structural Steel Main Members). Tasks in Tables N5.4-1 through N5.4-3 and Tables N5.6-1 through N5.6-3 listed for quality control (QC) are those inspections performed by the QCI(s) to ensure that the work is performed in accordance with the Contract Documents.

1. Non-destructive testing (NDT) of welded joints provided during fabrication shall be performed by either an independent and qualified testing agency or the qualified QCI(s). All testing reports shall be submitted to the Owner for review.
 - a. Conduct NDT of all welded joints primarily supporting gravity loads (i.e. cantilevers). Reduction in the rate of NDT per N5.5e is prohibited.
 - b. For Risk Category II structures, conduct NDT of 10% of remaining CJP groove welds for materials 5/16" thick and greater per ANSI/AISC 360 N5.5b.
 - c. For Risk Category III and IV structures, conduct NDT of all remaining CJP groove welds for materials 5/16" thick and greater per ANSI/AISC 360 N5.5b.
 - d. Conduct NDT of all welded joints subject to fatigue, where required by ANSI/AISC 360 Appendix 3, Table A-3.1. Reduction in the rate of NDT per N5.5e is prohibited.

- J. Special Inspections: Where special inspections are required by the Contract Documents, the Owner will engage the Special Inspector to perform an audit of the fabrication and quality control practices employed by the Fabricator. Where the Fabricator is qualified through the option noted in 1.8.A.1, the requirement for this audit during fabrication shall be waived.
 1. The Fabricator shall meet all requirements of ANSI/AISC 303 8.5 to accommodate an audit of the fabrication shop.
 2. Prior to the commencement of fabrication, the Special Inspector shall submit to the Owner for review a written plan identifying the frequency and extent of visits to the fabrication shop.
 3. At a minimum, the audit by the Special Inspector shall include review of the following:
 - a. The Fabricator's quality control manual and procedures for material control, inspection, and non-conformances.
 - b. Material test reports for all members, fasteners, and consumables.
 - c. The steel fabrication process including member fit-up, material selection, welding procedures and personnel, etc. Records need to be maintained for all material sources, members using the noted materials, consumables used, welder(s) employed, dates of completion, and when the QCI completed the inspection.
 - d. Inspections representing a sampling of the before, during, and after QA tasks noted in ANSI/AISC 360 N5.5, N5.6, and N5.8.

- K. At the completion of fabrication, the Fabricator shall submit a certificate of compliance to the Owner stating that the materials supplied and work performed by the Fabricator are in accordance with the Contract Documents. All testing/inspection reports generated as part of 2.7.I or 2.7.J shall also be submitted for review at the completion of fabrication.

2.8 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened.

- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize items as indicated on the Drawings.

2.10 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.

- C. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.
 - 1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Base Plates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Inspection Requirements: Quality control inspection tasks shall be performed by the Erector's QCI in accordance with ANSI/AISC 360 N5.4 (Inspection of Welding), N5.6 (Inspection of High-Strength Bolting), and N5.7 (Inspection of Galvanized Structural Steel Main Members). Tasks in

Tables N5.4-1 through N5.4-3 and Tables N5.6-1 through N5.6-3 listed for quality control (QC) are those inspections performed by the QCI(s) to ensure that the work is performed in accordance with the Contract Documents.

1. Non-destructive testing (NDT) of welded joints provided during erection shall be performed by an independent and qualified testing agency (see 3.3.J). All testing reports shall be submitted to the Owner for review.
 - a. Conduct NDT of all welded joints primarily supporting gravity loads (i.e. cantilevers). Reduction in the rate of NDT per N5.5e is prohibited.
 - b. For Risk Category II structures, conduct NDT of 10% of remaining CJP groove welds for materials 5/16" thick and greater per ANSI/AISC 360 N5.5b.
 - c. For Risk Category III and IV structures, conduct NDT of all remaining CJP groove welds for materials 5/16" thick and greater per ANSI/AISC 360 N5.5b.
 - d. Conduct NDT of all welded joints subject to fatigue, where required by ANSI/AISC 360 Appendix 3, Table A-3.1. Reduction in the rate of NDT per N5.5e is prohibited.
 - I. Special Inspections: Where special inspections are required by the Contract Documents, the Owner will engage a Special Inspector to perform the tasks noted in the Statement of Special Inspections during erection. These inspections shall be considered to satisfy the quality assurance requirements of ANSI/AISC 360 Chapter N.
 - J. Testing Agency: The Owner will engage an independent and qualified testing agency to perform tests and inspections.
 1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts".
 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M. Non-destructive testing (NDT) methods (as required) are as follows:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709, performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not acceptable.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 - K. At the completion of erection, the approved Erector shall submit a certificate of compliance to the Owner stating that the materials supplied and work performed by the Erector are in accordance with the Contract Documents.
- 3.4 FIELD CONNECTIONS
- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
 1. Joint Type: Snug tightened.
 - B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200

SECTION 052100 - STEEL JOIST FRAMING

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. K-series steel joists.
2. KCS-type K-series steel joists.
3. K-series steel joist substitutes.
4. LH-series long-span steel joists.
5. DLH-series long-span steel joists.
6. Steel joist girders.
7. Steel joist accessories.

- B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.

- B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Welding certificates.
- C. Manufacturer certificates.
- D. Mill Certificates: For each type of bolt.
- E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.
- F. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into cast-in-place concrete and masonry construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. CMC Joist & Deck.
 - 3. Gooder-Henrichsen Co.

4. New Millennium Building Systems, LLC.
5. Structures of U.S.A., Inc.
6. Valley Joist.
7. Vulcraft; Nucor Vulcraft Group.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.
 1. Use LRFD; data are given at factored-load level.
 2. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Floor Joists: Vertical deflection of 1/360 of the span.
 - b. Roof Joists: Vertical deflection of 1/240 of the span.
- B. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 50 percent.

2.3 STEEL JOISTS

- A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
 1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
 2. K-Series Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
 3. Provide holes in chord members for connecting and securing other construction to joists.
 4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
 5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated on Drawings, complying with SJI's "Specifications."
 6. Camber joists according to SJI's "Specifications."
 7. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.
- B. Long-Span Steel Joist: Manufactured steel joists according to "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows:
 1. Joist Type: LH-series long-span steel joists and DLH-series long-span steel joists.
 2. End Arrangement: Underslung.
 3. Top-Chord Arrangement: Parallel.
 4. Provide holes in chord members for connecting and securing other construction to joists.
 5. Camber long-span steel joists according to SJI's "Specifications."

6. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 STEEL JOIST GIRDERS

- A. Manufactured joist girders according to "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements as follows:
 1. End Arrangement: Underslung with bottom-chord extensions.
 2. Top-Chord Arrangement: Parallel.
 3. Provide holes in chord members for connecting and securing other construction to joist girders.
 4. Camber joist girders according to SJI's "Specifications."
 5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.5 PRIMERS

- A. Primer:
 1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.6 STEEL JOIST ACCESSORIES

- A. Bridging:
 1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. Hot-dip zinc coat according to ASTM A123/A123M.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 1. Finish: Plain.
- D. Welding Electrodes: Comply with AWS standards.
- E. Galvanizing Repair Paint: ASTM A780/A780M.
- F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.7 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 - 4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
- E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Touchup Painting:
 - 1. Immediately after installation, clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - b. Apply a compatible primer of same type as primer used on adjacent surfaces.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
- C. Visually inspect bolted connections.
- D. Prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100 - STEEL DECKING

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 deck.
- 2. Composite floor deck.
- 3. Non-composite form deck.

- B. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
- 2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.

- B. Sustainable Design Submittals:

- 1. Product Data: For recycled content, indicating post-consumer and pre-consumer recycled content and cost.

- C. Shop Drawings:

- 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Product Certificates: For each type of steel deck.

- C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Canam Steel Corporation; Canam Group, Inc.
 2. Cordeck.
 3. DACS, Inc.
 4. Epic Metals Corporation.
 5. Marlyn Steel Decks, Inc.
 6. New Millennium Building Systems, LLC.
 7. Nucor Corp.
 8. Roof Deck, Inc.
 9. Valley Joist.

- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating.
 2. Deck Profile: As indicated.
 3. Profile Depth: As indicated.
 4. Design Uncoated-Steel Thickness: As indicated.
 5. Span Condition: As indicated.
 6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 COMPOSITE FLOOR DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Canam Steel Corporation; Canam Group, Inc.
 2. Cordeck.
 3. DACS, Inc.
 4. Epic Metals Corporation.
 5. Marlyn Steel Decks, Inc.
 6. New Millennium Building Systems, LLC.
 7. Nucor Corp.
 8. Roof Deck, Inc.
- B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 50, G60 zinc coating.
 2. Profile Depth: As indicated.
 3. Design Uncoated-Steel Thickness: As indicated.
 4. Span Condition: As indicated.

2.4 NON-COMPOSITE FORM DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Canam Steel Corporation; Canam Group, Inc.
 2. Cordeck.
 3. DACS, Inc.
 4. Marlyn Steel Decks, Inc.
 5. New Millennium Building Systems, LLC.
 6. Nucor Corp.
 7. Roof Deck, Inc.

8. Valley Joist.

- B. Non-composite Form Deck: Fabricate ribbed-steel sheet non-composite form deck panels to comply with "SDI Specifications and Commentary for Non-Composite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 60, G60 zinc coating.
 2. Profile Depth: As indicated.
 3. Design Uncoated-Steel Thickness: As indicated.
 4. Span Condition: As indicated.
 5. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.5 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- I. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- J. Galvanizing Repair Paint: ASTM A780/A780M.
- K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF DECK INSTALLATION

- A. Fasten roof deck panels to steel supporting members as indicated.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.
- E. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FLOOR DECK INSTALLATION

- A. Fasten floor deck panels to steel supporting members as indicated.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped or butted at Contractor's option.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- E. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

STEEL DECKING

SECTION 05 31 00

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

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. Load bearing wall framing.
2. Exterior non-load bearing wall framing.
3. Interior non-load bearing wall framing exceeding height limitations of standard, non-structural metal framing.
4. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

- C. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Power-actuated anchors.
 - 4. Mechanical fasteners.
 - 5. Vertical deflection clips.
 - 6. Horizontal drift deflection clips
 - 7. Miscellaneous structural clips and accessories.
- E. Evaluation Reports: For non-standard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association or the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AllSteel & Gypsum Products, Inc.
 - 2. ClarkDietrich.
 - 3. Craco Manufacturing, Inc.

4. Custom Stud.
5. Formetal Co. Inc. (The).
6. Jaimes Industries.
7. MarinoWARE.
8. MBA Building Supplies.
9. MRI Steel Framing, LLC.
10. Nuconsteel, A Nucor Company.
11. Southeastern Stud & Components, Inc.
12. State Building Products, Inc.
13. Steel Construction Systems.
14. Steel Structural Systems.
15. Super Stud Building Products Inc.
16. Telling Industries.
17. The Steel Network, Inc.
18. United Steel Deck, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 1. Design Loads: As indicated on Drawings.
 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Load bearing Wall Framing: Horizontal deflection of 1/240 of the wall height. Increase limit to 1/600 of the wall height at locations backing up brick façade.
 - b. Interior Load bearing Wall Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
 - c. Exterior Non-Load bearing Framing: Horizontal deflection of 1/240 of the wall height. Increase limit to 1/600 of the wall height at locations backing up brick façade.
 - d. Interior Non-Load bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 80 deg F.
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch.

5. Design exterior non-load bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Wall Studs: AISI S211.
 2. Headers: AISI S212.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance.
 2. Coating: G60, A60, AZ50, or GF30.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance.
 2. Coating: G60.

2.4 LOAD BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1-1/4 inches.
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1-5/8 inches.

2.5 EXTERIOR NON-LOAD BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AllSteel & Gypsum Products, Inc.
 - b. ClarkDietrich.
 - c. MarinoWARE.
 - d. Simpson Strong-Tie Co., Inc.
 - e. Steel Construction Systems.
 - f. The Steel Network, Inc.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1 inch plus the design gap for one-story structures.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 INTERIOR NON-LOAD BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch.
 - 2. Flange Width: 1-3/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AllSteel & Gypsum Products, Inc.
 - b. ClarkDietrich.
 - c. MarinoWARE.
 - d. Simpson Strong-Tie Co., Inc.
 - e. The Steel Network, Inc.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1 inch plus the design gap for one-story structures.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.7 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1-5/8 inches, minimum.

2.8 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
1. Supplementary framing.
 2. Bracing, bridging, and solid blocking.
 3. Web stiffeners.
 4. Anchor clips.
 5. End clips.

6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.9 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
- B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193, ICC-ES AC58, or ICC-ES AC308 as appropriate for the substrate.
 1. Uses: Securing cold-formed steel framing to structure.
 2. Type: Screw or adhesive anchor.
 3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.10 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M or SSPC-Paint 20.
- B. Non-metallic, Non-shrink Grout: Factory-packaged, non-metallic, non-corrosive, non-staining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- C. Shims: Load bearing, high-density, multi-monomer, non-leaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

- D. Sealer Gaskets: Closed-cell neoprene foam, 1/4-inch-thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.11 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load bearing shims or grout between the underside of load bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 LOAD BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 - 1. Anchor Spacing: As shown on Shop Drawings.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 - 1. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
 - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- I. Install horizontal bridging in stud system, spaced vertically as indicated on Shop Drawings. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- J. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 EXTERIOR NON-LOAD BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:
1. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
1. Install single deep-leg deflection tracks and anchor to building structure.
 2. Connect vertical deflection clips to bypassing studs and anchor to building structure.
 3. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
1. Install solid blocking at centers indicated on Shop Drawings.

- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INTERIOR NON-LOAD BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Connect vertical deflection clips to studs and anchor to building structure.
 - 3. Connect drift clips to cold-formed steel metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.7 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.8 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 05 50 00 - METAL FABRICATIONS

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. Aluminum ladders.
2. Loose bearing and leveling plates.
3. Loose steel lintels.
4. Miscellaneous framing and supports.
5. Metal edgings.
6. Miscellaneous metal trim.

- B. Related Sections include the following:

1. Division 05 Section "Structural Steel Framing" for structural-steel framing system components.
2. Division 05 Section "Pipe and Tube Railing" for metal pipe and tube handrails and railings.
3. Division 06 Section "General Carpentry" for metal framing anchors and other rough hardware.

1.3 SUBMITTALS

- A. Product Data: For the following:

1. Grout.

- B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1. Provide templates for anchors and bolts specified for installation under other Sections.

- C. Samples for Verification: For each type and finish of extruded nosing and tread.

- D. Welding Certificates: Copies of certificates for welding procedures and personnel.

- 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.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications 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. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.6 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. 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.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- C. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- D. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.
- E. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- F. Slotted Channel Framing: Cold-formed metal channels with flange edges returned toward web and with 9/16-inch wide slotted holes in webs at 2 inches on center.
 - 1. Width of Channels: 1-5/8 inches.

2. Depth of Channels: As indicated.
3. Metal and Thickness: Galvanized steel complying with ASTM A 653/ A 653M, structural quality, Grade 33, with G90 coating; 0.108-inch, 0.079-inch or 0.064-inch nominal thickness (as required for load imposed).
4. Metal and Thickness: Cold rolled steel complying with ASTM A 1008/ A 1008M, Grade 33; 0.0966-inch, 0.0677-inch or 0.0528-inch minimum thickness (as required for load imposed).
5. Finish: Unfinished where not exposed.
6. Finish: Rust-inhibitive, baked-on, acrylic enamel finish where exposed to view or to the exterior.

G. Malleable-Iron Castings: ASTM A 47, Grade 32510.

H. Gray-Iron Castings: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.

I. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

J. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.3 ALUMINUM

A. Aluminum Extrusions: ASTM B 221, alloy 6063-T6.

B. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, alloy 6061-T6.

2.4 PAINT

A. Shop Primers: Provide primers that comply with Division 9 Section "Painting."

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FASTENERS

A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

- C. Anchor Bolts: ASTM F 1554, Grade 36.
- D. Machine Screws: ASME B18.6.3.
- E. Lag Bolts: ASME B18.2.1.
- F. Wood Screws: Flat head, carbon steel, ASME B18.6.1.
- G. Plain Washers: Round, carbon steel, ASME B18.22.1.
- H. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- I. 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 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 agency.
- J. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.6 GROUT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.7 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Weld corners and seams continuously to comply 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. 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.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Allow for thermal movement resulting from the maximum change in ambient and surface temperatures (temperature range) by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night-time sky heat loss.
- I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- J. Remove sharp or rough areas on exposed traffic surfaces.
- K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.8 ALUMINUM LADDERS

- A. Manufacturers: Subject to compliance with requirements. Standard Duty Channel Rail with Safety Post. Model 500 as manufactured by O’Keeffe’s Inc., available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Alco-Lite Industrial Products; 800-752-2526; <http://www.aluminumladder.com/>
 - 2. O’Keeffe’s Inc.; 888-653-3333; www.okeeffes.com
 - 3. Precision Ladders, LLC; 423-586-2265; <http://www.precisionladders.com/>
- B. Manufacturer has responsibility for an extended Corrective Period for work of this Section for a period of 5 years commencing on the shipment date of the product against all the conditions indicated below, and when notified in writing from Owner, manufacturer shall promptly and without inconvenience and cost to Owner correct said deficiencies.

2.9 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates after fabrication.

2.10 LOOSE STEEL LINTELS

- A. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 8 inches, unless otherwise indicated.
- D. Shop prime loose steel lintels located in exterior walls.

2.11 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 1-1/4 inches wide by 1/4 inch thick by 8 inches long at 24 inches on center, unless otherwise indicated.
 - 3. Furnish inserts if units must be installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.

2.12 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches o.c., unless otherwise indicated.
- C. Galvanize miscellaneous steel trim where indicated on drawings.

2.13 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.14 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing steel and iron products.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

2.15 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- 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, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. 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.
- E. Field Welding: Comply with the following requirements:
 - 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.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 SETTING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated at girders supported on concrete or masonry, install as specified above for setting and grouting bearing and leveling plates.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified above for setting and grouting bearing and leveling plates.
 - 1. Do not grout baseplates of columns supporting steel girders until girders are installed and leveled.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 00

Division 06 – Wood, Plastics, and Composites

SECTION 06 20 00 - GENERAL CARPENTRY

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all labor, materials, equipment and services required to complete the general carpentry work, miscellaneous equipment and material installation.

1.2 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
 - 1. Include data for wood-preserved and fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that the treated materials comply with requirements.

1.3 QUALITY ASSURANCE:

- A. Lumber standards: Comply with DOC PS 20 and with applicable rules of the respective agencies for species and products specified.
- B. Plywood product standards: Comply with DOC PS 1 (ANSI A199.1) or, for products not manufactured under DOC PS 1 provisions, with applicable APA Performance Standard for type of panel indicated. Reference DOC PS 2 for OSB.

1.4 PRODUCT HANDLING:

- A. Do not deliver shop fabricated carpentry items until site conditions are adequate to receive the work. Protect items from weather while in transit.
- B. Store indoors, in ventilated area with a constant, minimum temperature of 60 degrees F, maximum humidity of 25 to 55 percent.

PART 2 - PRODUCTS

2.1 LUMBER:

- A. Dimensions: Conform to standards established by the American Lumber Standards Committee.
- B. Moisture content: Unseasoned or 19% maximum at the time of permanent closing in of the structure.
- C. Surfacing: S4S.
- D. Miscellaneous lumber: Provide wood for support or attachment of other work including, but not limited to, cant strips, bucks, nailers, plates, blocking, bracing, furring, grounds, stripping and similar members. Provide lumber of sizes indicated, worked into shapes shown. Shall be #2, GM, SYP, KDAT (Kiln Dried After Treatment).

2.2 PLYWOOD - GENERAL:

- A. Identify each panel with the appropriate grade APA trademark and shall meet the requirements of the latest edition of U.S. Product Standard PSI or one of APA's Performance Standards.
- B. All plywood which has an edge or surface permanently exposed to the weather shall be classed Exterior.
- C. Panel thickness, grade, and Group or Identification Index shall be at least equal to that shown on the Drawings. Installation shall be in accordance with the APA recommendations.

2.3 WOOD TREATMENT - PRESERVATIVE:

- A. Lumber or plywood shall be preservative treated in the following instances.
 - 1. Whenever wood is placed in the ground;
 - 2. Whenever wood is placed in water;
 - 3. Whenever wood comes in contact with masonry or concrete;
 - 4. Wherever wood is exposed to wetting and corrosive environments;
 - 5. Whenever wood would be susceptible to decay organisms or insects.
- B. Comply with applicable requirements of AWPA Standards U1. Mark each treated item with the AWPA Quality Mark Requirements.
- C. Water-borne preservatives shall comply with AWPA T1 applicable. After treatment, kiln-dry to a maximum moisture content of 15%.
- D. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.4 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWPA U1.
 - 1. Where indicated, use type USFB for exterior locations.
 - 2. Where indicated, use type USFB for interior locations.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Application: Treat items where indicated on Drawings.

2.5 WOOD NAILERS AT ROOF PERIMETER FOR MEMBRANE ROOFING:

- A. Nailers shall be #2 or better lumber wolmanized for pressure, treated for fire and rot resistance. Creosote and asphaltic preservatives are not acceptable. Surface height of nailers shall be matched to that of the insulation thickness being used.

2.6 FASTENERS AND ANCHORAGE:

- A. Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices. Provide metal hangers and framing anchors of the size and

type recommended by the manufacturer for each use including recommending nails.

- B. Where rough carpentry work is exposed to weather, in ground contact, or in area of high humidity, provide fasteners and anchorages with hot-dip zinc coating (ASTM A 153).

2.7 MISCELLANEOUS MATERIALS

- A. Paneling Adhesive: Comply with paneling manufacturer's written recommendations.
 - 1. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 GENERAL:

- A. 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.
- B. Set carpentry work accurately to required levels and lines, with members plumb, true and accurately cut and fitted.
- C. 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.
- D. Use common wire nails, except as otherwise noted. 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; predrill as required.

3.2 WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS:

- A. Provide for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
- B. Attach to substrates to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.
- C. Provide permanent grounds of dressed, preservative treated, key-beveled lumber not less than 1-1/2" wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

3.3 WOOD NAILERS AT ROOF PERIMETER FOR MEMBRANE ROOFING:

- A. Install wood nailers at the roof perimeter for the installation of membrane roofing. Anchor firmly to deck at 3'-0" on center to resist a force of 175 lbs. per linear foot in any direction. Where the deck consists of material with limited holding capability, the anchoring shall be accomplished by fastening to the supporting steel or with toggle bolts penetrating to the underside of the deck or such means as may be approved in writing by the roof manufacturer. 1/2" vent spaces shall be provided between adjacent lengths of nailers.

END OF SECTION 06 20 00

SECTION 06 22 00 – MILLWORK

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all of the labor, materials, equipment and services required to furnish and install the millwork.

1.2 QUALITY ASSURANCE:

- A. In addition to complying with all pertinent codes and regulations, the latest edition “Architectural Woodwork Standards” of the Architectural Woodwork Institute shall apply and by reference are hereby made a part of these Contract Documents. Any reference to “premium”, “custom”, or “economy” shall be defined in the latest edition of AWI “Architectural Woodwork Standards”.

1.3 SUBMITTALS:

- A. Prior to fabrication, submit to the Architect for review the following:
 - 1. Shop drawings that at a minimum shall show the following:
 - a. All materials (solid wood, plywood, fiberwood board, plastic laminate, solid surface, and hardware).
 - b. All thicknesses and dimensions.
 - c. Specie, grade and cut of woods and veneers.
 - d. Jointing and bolting.
 - e. The name of the manufacturer and the model number of all factory fabricated items.
 - f. Full size details drawn in related and dimensioned positions to facilitate checking of intersecting and string dimensions.
 - g. Clear description of work to be done in the shop and work to be done in the field.
 - 2. Manufacturer’s literature of specialty items not manufactured by the architectural woodworker.
 - 3. Physical samples:
 - a. Plastic laminate in all colors and patterns for the Architect’s selection.
 - b. Upon request, provide one unit of each type and finish of hardware
- B. Certification: Submit copies of certificate signed by woodwork shop certifying that millwork complies with quality grades and other requirements indicated. Form of certificate shall be approved by the Architect.

1.4 PRODUCT HANDLING:

- A. Millwork shall not be delivered until the building and storage areas are sufficiently conditioned so that the millwork will not be damaged by excessive changes in moisture content.

PART 2 - PRODUCTS

2.1 CASEWORK, SHELVES AND COUNTERTOPS - PLASTIC LAMINATE FINISH:

- A. AWI quality grade: Custom
 - 1. Acceptable Manufacturers:
 - a. Wilsonart
 - b. Formica
 - c. Pionite
 - b. See Finish Schedule for basis of design
- B. Exposed surfaces – general purpose plastic laminate: 0.048 inches (1.2mm) nominal approximately 1/16" thick high-pressure plastic laminate; Vertical Surface Laminate Product 0.028 inch (0.7 mm) nominal and High Definition Laminate 0.039 inch (1.0 mm) nominal as required by AWI quality grade and conforming to NEMA LD 3, Grade HGS, VGS, VGP & HGP and ISO 4586, Grade HGS, VGS, VGP & HGP. Abrasion Class I.
- C. All plastic laminate countertops in which sinks occur shall have a core of exterior grade hardwood faced plywood.
- D. Casework body members (ends, divisions, fixed shelves, bottoms, tops, face frames, bases, rails, toe kicks, backs, drawer sides, drawer bottoms) to be made of cabinet grade plywood per AWI standards.
- E. Drawer fronts and cabinet doors with dimensions up to 30" width x 80" height shall be constructed from 3/4" minimum MDF or panel product.
- F. **NO PARTICLE BOARD IS ALLOWED ON SITE.**
- G. Provide all vertical and horizontal filler material required for a complete installation
- H. Edgebanding shall be HPDL or .03 mm flat PVC color to coordinate with face laminate.
- I. Provide laminate on toekicks that matches the base cabinet laminate.
- J. Grain pattern of laminate shall be in the same direction on all components, doors face, cabinet frame, drawer face, toekick.

2.2 SOLID SURFACE COUNTER:

- A. SSF-1, Basis of Design (window sills)
Non-porous solid surface 1/2" thickness unless otherwise noted on drawings.
 - 1. Acceptable Manufacturers: as
 - a. Wilsonart
 - b. Corian
 - c. Formica
 - 2. Finish: as scheduled.
 - 3. See Finish Schedule for basis of design, See drawings for locations of solid surface and profile trim where applicable.
- B. Solid Surface Counter support where applicable:
 - 1. Counter to be installed on square tube stock or angle iron support framing when not over cabinetry or casework. Support framing to include perimeter supports, perimeter supports at cutouts, and cross supports where necessary.

- a. Maximum deflection of solid surface to be 1/8" (3 mm) over 10 feet (3 m)
2. Where underlayment is indicated, install solid surface over 3/4" plywood underlayment. If spacers are required, they are to be moisture-resistant MDF or moisture-resistant plywood.
3. All counter surfaces that do not have cabinets below require a 3/4" plywood substrate underlayment to avoid future cracking of the solid surface counter.
4. Solid surface counter edges at overhangs to be built-up construction unless noted otherwise.

2.3 CASEWORK HARDWARE:

- A. All cabinet hardware shall be furnished and installed by the casework manufacturer.
 1. Drawer slides:
 - a. Full extension slides for file drawers
 - b. White Euroslides for typical drawers
 - c. Manufacturers: Accuride, Mepla, Hafele, or Knap & Vogt.
 2. Line boring with metal shelf clips.
 3. Hinges: 120-degree concealed casework hinges with self-closing feature.
 - a. Provide number of hinges per manufacturer's recommendations. In no case less than:
 - i. Three (3) hinges per door with a height 40" or greater or a weight between 15-30 lbs
 - ii. Four (4) hinges per door with a height 60" or greater or a weight between 30-45 lbs
 - iii. Five (5) hinges per door with a height of 80" or greater or a weight between 45-60 lbs
 - b. Where wheelchair accessibility is required for base cabinets with sink, provide 170-degree concealed casework hinges with magnetic catches.
 - c. Manufacturers: Blum, Salice, Hafele or Grass.
 4. Pulls: Richelieu; 7516192170AB 7 9/16" width, in stainless steel finish.
 5. Locks: Cam locks where noted on drawings.
 - a. All locks to be separately keyed with a master key provided.
 - b. Manufacturers: National or approved equal
 6. Silencers: Provide a minimum of 2 silencers for each cabinet door and drawer.

PART 3 - EXECUTION

3.1 PREPARATION FOR FINISHING:

- A. Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing of concealed surfaces and similar preparations for finishing of millwork as applicable to each unit of work.
- B. Shop Finishing: to the greatest extent possible, finish millwork at shop or factory. Defer only final touch-up, cleaning and polishing for times after delivery and installation.

3.2 PREPARATION FOR INSTALLATION:

- A. Condition millwork to average prevailing humidity conditions in installation areas prior to installing.
- B. Coordinate installation of backing for support, before walls are built.

3.3 INSTALLATION:

- A. Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8" in 8'-0" for plumb and level; and with 1/16" maximum offset in flush adjoining surfaces, 1/8" maximum offsets in revealed adjoining surfaces.
- B. Scribe and cut work to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.
- C. Anchor millwork to anchors or built-in blocking. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with millwork, and matching final finish where transparent finish is indicated.

3.4 CASEWORK:

- A. Set and secure casework in place rigid, plumb and square.
- B. Use purpose designed fixture attachments for wall-mounted components. Attach wall-mounted cabinets in order that they can withstand all superimposed loading.
- C. Use thread steel concealed joint fasteners to align and secure adjoining cabinet units and counter tops.
- D. Permanently fix cabinet and counter bases to floor using appropriate angles and anchorages.
- E. Counter-sink semi-concealed anchorage devices used to wall mount components, and conceal with solid plugs of species to match surrounding wood. Place flush with surrounding surfaces.
- F. Carefully scribe cabinetwork which is against other building materials leaving gaps of 1/32" maximum. Seal gaps with sealant tinted to match adjacent surfaces. Do not use additional overlay trim for this purpose.
- G. Install and adjust cabinet hardware to ensure smooth and correct operation.

3.5 ADJUSTMENT, CLEANING, FINISHING AND PROTECTION:

- A. Repair damaged and defective millwork wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace millwork. Adjust joinery for uniform appearance.
- B. Clean hardware, lubricate and make final adjustments for proper operation.
- C. Clean millwork on exposed and semi-exposed surfaces. Touch-up shop-applied finishes to restore damaged or soiled areas.
- D. Provide final protection and maintain conditions, in a manner acceptable to fabricator and installer, which ensures millwork being without damage or deterioration at time of Substantial Completion.

END OF SECTION 06 22 00

SECTION 06 82 00 – GLASS FIBER REINFORCED PLASTIC

PART 1 - GENERAL

1.01 SCOPE:

- A. Furnish all labor, materials, equipment and services necessary or indicated to the completion of fiber reinforced plastic columns and associated work in accordance with the Contract Documents and all applicable building codes.

1.02 QUALITY ASSURANCE:

- A. Manufacturer: A firm with not less than 10 years successful experience in producing the type of prefabricated components required for project applications equivalent to the requirements for this project.
- B. Installer: Shall have a minimum of 5 years of successful experience with the type of prefabricated components specified and shall be technically instructed and approved by the prefabricated component manufacturer.
- C. Installers responsibilities include, but are not limited to the following items:
 - 1. Examine and study the Drawings and Specifications to ensure the work, as described, is complete, and submit written notification to the General Contractor of all discrepancies. Direct requests for clarification of conditions to the General Contractor.
 - 2. Examine and study the Drawings and Specifications with regard to the surfaces and structural framing to which all applicable work in this Section is attached and/or anchored. Submit written notification to the General Contractor of all deficiencies and detrimental factors which would affect proper and timely installation of the work of this Section. Furnish and install supplementary parts necessary to complete items described on the Drawings and in the Specifications, even though not definitely shown or specified. Design and size support systems to meet the performance requirements. Furnish and install clips, bracing, and steel framework for proper anchorage of prefabricated elements to the structure.
 - 3. Coordinate and verify, by measurement at the Project Site, all dimensions affecting work of this section. Bring field dimensions which are at variance with those on the approved shop drawings to the attention of the General Contractor. Obtain decisions regarding corrective measures for the General Contractor before the start of installation of affected items. Assure compatibility of adjacent items in relationship to work of this section. Corrective measures which affect appearance or performance of this work shall be brought to the attention of the Architect.
 - 4. Cooperate with the General Contractor in the coordination and scheduling of the work in this Section with the work of other Sections so as not to delay job progress. Proceed with work only after substrate construction has been completed
- D. Coordination Meetings: Prior to installation, meet at the Project Site with the installer and manufacturer's representative to coordinate dimensional layout, working points and reference lines, inserts, scheduling of related work, protection, and other requirements affecting the successful completion of the work of this Section.
- E. Anchorage and Support of Prefabricated Elements: Except where specifically shown otherwise on Structural Drawings, provide all suspension, bracing, and connection elements

and assemblies for support of prefabricated work.

- F. Allowable Tolerances. Finished surfaces shall not vary more than 1/8" in 10'-0" when tested with a straight edge and shall be free from cracks, pits, chips, voids, depressions, bumps, blisters, ridges, waves, scratches, cat faces, discoloration or other defacement.

1.03 SUBMITTALS:

- A. Product Data: Submit copies of manufacture's specifications and installation instructions for each prefabricated component required. Include reports and other data as may be required to show compliance with the Specifications.
- B. Submit shop drawings for approval showing plans, sections, details, joint treatment, reinforcing, fastening devices, and relation to adjacent construction as required.
- C. Fiber Reinforced Plastic: Sample panels will be provided to the Architect for review and approval of color and texture. Submit 2 sets of 12" square samples. Each set of samples shall show the full range of color and texture to be expected in the completed work.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Store materials delivered to the Site in space(s) provided by the General Contractor on appropriate floors of the building to permit easy access to and handling of the materials. Store materials neatly, properly stacked on dunnage within the stacking heights permitted by the manufacturer, protected from warping and damage. The Contractor shall not be required to move except for installation.
 - 1. Transport, handle, and store system units and components in a manner to preclude damage.
 - 2. Deliver accessory materials in manufacturer's labeled containers.
 - 3. Exercise care in handling and protect all materials and finishes during fabrication, shipment, storage, and erection as necessary to prevent damage to the finished surfaces.
 - 4. Remove all units and components which are cracked, bent, chipped, scratched, or otherwise unsuitable for installation and replace with new, approved items.

1.05 WARRANTY:

- A. The manufacturer of the composite products and the Contractor shall jointly warrant the products to be free from defects in materials and workmanship for a period of one year from date of substantial completion of the project and if defects in materials and/or workmanship should appear within the stated period of warranty, the Manufacturer and Contractor shall replace same without additional cost to the Owner. Manufacturer's warranty shall be limited to replacement of defective materials and Contractor shall install replacement items without additional cost to the Owner or Manufacturer.

PART 2 - PRODUCTS

2.01 COMPOSITE FABRICATIONS:

- A. Provide manufacturer's standard composite formulation designed for exterior or interior, as required. Provide integrally colored units with an approved surface texture for a consistent appearance to match the architectural requirements. Surface finish to incorporate integral

aggregate with a light sandblasted finish for the precise simulation of cut limestone.

- B. Inserts: Provide threaded inserts, internal reinforcements, stiffeners and steel connection devices incorporated into units with corrosion resistant coating such as zinc or cadmium plate, or stainless steel. Embed inserts and stiffeners in reinforced laminates to develop their strength and prevent failure.

2.02 MATERIAL SPECIFICATIONS:

- A. Acceptable manufacturer:
1. Spaulding Craft, Inc. (SCI)
Safety Harbor, FL 34695
(813) 726-2316
 2. Fibertech
(864) 646-3000
 3. Or approved equal under Division 01.
- B. Basis of design: FRP-1, Crane Composites, Varietex, Satin Sandstone, 09" (2.3 MM). Reference A700 Interior Finish Schedule for specifications. Reference Room Finish Schedule and Finish plans for locations.

Fire Retardant Rating:

1. Fire retardant material must meet or exceed ASTM E-84 Tunnel Test
- C. Physical Properties: Must meet or exceed ASTM D-790.

PHYSICAL PROPERTIES OF SCI GLASS REINFORCED LAMINATES

Flexural Strength at 77 deg. F, psi	ASTM D-790	27,000
Flexural Modulus at 77 deg. F, x 10(6) spi	ASTM D-790	1.5
Tensile Strength at 77 deg. F, psi	ASTM D-648	18,000
Compressive Strength at 77 deg F, edgewise, psi	ASTM D-695	27,000
24 Hr. Water Absorption at 77 deg. F, % Change in weight	FTMS-7031	0.05
Barcol Hardness	ASTM D-2583	55-65
Glass Content,	FTMS-7061	30

2.03 FABRICATION:

- A. Workmanship: Use materials of the required size and thickness to produce adequate strength and durability in the finished product and for the intended use. Work to the dimensions shown or accepted on shop drawings using proven details of fabrication and support.
- B. Connections:
1. Combinations of bolts and welds in the same connections are not permitted, unless otherwise detailed.
 2. Weld shop connections, unless otherwise shown.
 3. Bolt field connections, except where welded connections or other connections are shown or specified.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. General: Install materials in accordance with manufacturer's printed instructions, to comply with governing regulations, and under the constant supervision of a competent foreman experienced in the installation of systems of the type specified. Carefully plan and lay out the work as necessary to carry out the intent of the Drawings, and to properly accommodate related work as indicated and specified.
- B. Installer must examine conditions under which work is to be performed and must notify Contractor in writing of unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- C. Secure individual units as indicated, accurately fitted true to line and slopes as indicated and required for proper alignment with adjacent work.

3.02 CLEAN-UP AND PROTECTION:

- A. Clean surfaces of units and exposed suspension systems; comply with manufacturer's instructions. Remove and replace units and members which are damaged or cannot be cleaned.
- B. The installer shall advise the Contractor of proper procedures required for protection of work from damage or deterioration until acceptance of the work.

END OF SECTION 06 82 00

Division 07 - Thermal & Moisture Protection

SECTION 07 21 13 - BOARD INSULATION

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all of the labor, materials, equipment, and services required to furnish and install the rigid board insulation.

1.2 SUBMITTALS:

- A. Prior to installation, submit to the Architect for review the following:
 1. Manufacturer's product data indicating physical and thermal properties, and the manufacturing process.
 2. Manufacturer's installation instructions for this Project.

1.3 DELIVERY AND STORAGE:

- A. Deliver in original packages, containers, or bundles bearing manufacturer's labels indicating the brand name and descriptive data confirming compliance with requirements herein specified.

PART 2 - PRODUCTS:

2.1 CAVITY WALL INSULATION:

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Owens Corning Co. – Foamular NGX 250 Extruded Polystyrene (XPS) Rigid Foam Insulation
 - 2) DuPont Styrofoam Brand XPS Insulation
 - 3) Kingspan GreenGuard GG25 LG XPS Insulation BoardOr Approved Equal.
- B. Extruded polystyrene foam, square edge.
Standard: ASTM C177, ASTM C272, ASTM E96
Flamespread: 5
Maximum smoke development: 165
- C. Dimensions as noted on drawings.

2.2 ADHESIVE:

- A. Adhesive recommended by the insulation manufacturer for the application involved.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that substrate and adjacent materials, and insulation boards, are dry and ready to receive insulation and adhesive.
- B. Verify that substrate is flat and free of irregularities and materials that will impede adhesive bond.
- C. Verify that insulation boards are unbroken and free of damage, including board skin.

3.2 CAVITY WALL INSTALLATION:

- A. Install insulation board horizontally within the cavity space against the inner wythe by using construction grade adhesive with wall ties located at the insulation board joints.
- B. Apply adhesive to substrate in accordance with the adhesive manufacturer's instructions for the application. Apply to the coverage recommended for the application.
- C. Cut insulation neatly to fit around obstructions, across cavities such as vents, louvers, pipes, and conduit. Do not leave open spaces and loosely fitted joints where water might enter.
- D. Install boards horizontally between cavity ties. Stagger end joints. Butt edges tight to adjacent boards and protrusions.
- E. Take care to ensure insulation boards are butted tightly together at joints, are fully adhered, and fit flush against back-up wall.

3.3 CLEAN-UP:

- A. When work is completed, clean up and remove excess materials and tools from job site.

END OF SECTION 07 21 13

SECTION 07 21 16 - BLANKET INSULATION

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all of the labor, materials, equipment, and services to furnish and install the blanket insulation.

1.2 SUBMITTALS:

- A. Prior to installation, submit to the Architect for review the following:
 - 1. Manufacturer's catalog data fully describing the product and indicating installation recommendations.

1.4 DELIVERY:

- A. Deliver materials in original packages, containers, or bundles bearing manufacturer's labels. Labels shall indicate brand name and descriptive data confirming compliance with requirements herein specified.

1.5 PROTECTION:

- A. Keep materials dry, protected against moisture, weather, and damage.

PART 2 - PRODUCTS

2.1 UN-FACED BATT INSULATION:

- A. Mineral or fiberglass composition conforming to ASTM C665, Type I. Produce insulation by combining thermosetting resins with mineral fibers manufactured from glass, slag wool or rock wool.
- B. Thickness: See Drawings.
 - 1. 3 ½" = R-11
 - 2. 6" = R-19
 - 3. 9" = R-30
 - 4. 3 ½" = R-11 for sound attenuation batts
- C. Provide nylon mesh for support where insulation is suspended between bottom chords of roof trusses.
- D. When used in fire-resistance-rated assemblies, comply with mineral-fiber requirements of assembly.

2.2 SPANDREL INSULATION:

- A. Fiberglass composition conforming to ASTM C665 Type I. Where indicated on Drawings, provide insulation with foil-backing toward "warm" side of wall assembly.
- B. Thickness - 2 ½".

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install insulation in accordance with the manufacturer's printed instructions without gaps or voids.
- B. Trim insulation to neatly and tightly fit spaces. Use batts free of damage.
- C. Install in the number of layers necessary to achieve the required thickness.
- D. Physically and permanently attach batts to framing so as to prevent downward slippage of batt. Support relying on friction alone will not be allowed.
- E. Back-fill above suspended ceiling systems:
 - 1. Install insulation between wire rods, perpendicular to ceiling system main tees. Batts should fit tightly together.
 - 2. Wire rod, chicken wire, or wire may be needed to hold insulation in place.
 - 3. Do not install insulation on top of, or within 3 inches of recessed light fixtures unless the fixtures are approved for such use.
 - 4. Refer to ceiling system manufacturer's recommendations on maximum back-loading recommendations and to ensure proper installation.

3.2 CLEAN UP:

- A. When work is completed in each area, remove debris, equipment, and excess material and leave area broom clean.

END OF SECTION 07 21 16

SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fluid-applied, vapor-permeable membrane air barriers performing as a continuous air barrier, and as a liquid-water drainage plane flashed to discharge incidental condensation or water penetration to the exterior.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Attendance is required of representatives of related trades including those responsible for installing covering materials, substrate materials, and adjacent materials and the product manufacturer's representative.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build integrated mockups of exterior wall assembly 150 sq. ft., incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.

- a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
- b. Include junction with roofing membrane, building corner condition and foundation wall intersection.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing 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: Maximum 0.04 cfm/sq.ft. of surface area at 1.57 lbs/sq.ft., when tested according to ASTM E 2357.

2.3 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER

- A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: synthetic polymer membrane.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Synthetic Polymer Membrane:
 - 1) Carlisle Coatings & Waterproofing Inc.; Barritech VP.
 - 2) DuPont Tyvek Fluid Applied WB.;
 - 3) GCP-Grace; Perm-A-Barrier VPL 50
 - 4) Tremco Incorporated, an RPM company; ExoAir 230.
 - 5) W.R. Meadows Airshield LMP
 - 6) Prosoco R-Guard Spray Wrap MVP
 - 7) Henry Air Bloc 17MR
 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
 - b. Vapor Permeance: Minimum 10 perms; ASTM E 96 Method B.
 - c. Ultimate Elongation: Minimum 250 percent; ASTM D 412, Die C.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
- B. Sprayed Polyurethane Foam Sealant: One- or two-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.
- C. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- B. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- C. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- D. 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.
 - 1. Material: Detail membrane shall consist of one of the following compatible materials:
 - a. Bituminous Sheet Membrane
 - b. Polyether Liquid Flashing
 - 2. Locations: Apply detail membranes as indicated in the documents and at the following conditions:
 - a. Building tie-ins
 - b. Window openings
 - c. Control Joints
 - d. Changes in substrate
 - 3. Supplemental Material: If a space greater than ½" exists, fill the opening with a rigid supportive material such as joint sealant, spray foam or insulation.

3.2 INSTALLATION

- A. General: Install fluid-applied membrane air-barrier and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Prior to installing over sheathing, all fasteners must be flush with the sheathing surface. A 3" reinforcing fabric shall be used at all seams, imbedded on the first wet application of the fluid applied air barrier.

2. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 3. Install air-barrier assembly on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of air barrier to substrate with termination mastic.
- E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transitions and flashing so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.
- F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- G. Seal air-barrier assembly around masonry reinforcing or ties and penetrations with termination mastic.
- H. Seal top of through-wall flashings to air barrier.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- J. Repair punctures, voids, and deficient lapped seams. Slit and flatten fishmouths and blisters. Extend patches 6 inches beyond repaired areas.
- K. Fluid-Applied Membrane Material: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
1. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements applied in one or more equal coats. Apply additional material as needed to achieve void and pinhole free surface, **BUT DO NOT EXCEED THICKNESS UPON WHICH THE REQUIRED VAPOR PERMEABILITY IS BASED.**
- L. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements.
- B. Protect air-barrier system from 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. If exposed to these conditions for more than 60 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
 - 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- C. Remove masking materials after installation.

END OF SECTION 07 27 26

SECTION 07 27 29 - SPRAY-APPLIED INSULATING AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Spray-applied urethane foam insulation and air barrier system.

- B. Related Sections include the following:

- 1. Division 03 through 14 Sections for facility exterior enclosure testing and inspection requirements specific to the Work of each Section with products forming interface with Work of this Section.
 - 2. Division 04 Section "Unit Masonry" for embedded flashings in contact with material provided in this Section and additional mockup panel requirements
 - 3. Division 07 Section "Thermal Insulation" for board insulation.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal flashings.
 - 5. Division 07 Section "Joint Sealants" for joint-sealant materials and installation, and for preconstruction testing for compatibility of joint sealants in contact with materials specified in this Section.

1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. 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.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Meet with Owner, Architect, Owner's BxA representative, testing and inspecting agency representative, air barrier Installer, air barrier manufacturer's representative, air barrier substrate Installers, and other installers whose work interfaces with, penetrates, or affects air barrier installation, including installers of windows, doors, storefront assemblies, curtain walls, and louvers.
 - 2. Review mockup construction and testing requirements.

3. Review methods and procedures related to air barrier installation, including manufacturer's written instructions.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to interface with cladding installation, make progress, and avoid delays.
5. Review substrate requirements for conditions and finishes, including flatness and fastening.
6. Review flashings, special opening and penetration details, and condition of other construction that will affect air barriers.
7. Review temporary protection requirements for air barriers during and after installation.
8. Review air barrier observation, inspection, testing, and repair procedures after installation.

1.5 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.
 1. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
- B. Shop Drawings: Show locations and extent of insulating air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 1. Include details of interfaces with other materials that form part of air barrier.
 2. Include details of mockups.
- C. Coordination Drawings: Prepare and submit Project-specific Coordination Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved. Include the following information, as applicable:
 1. Refer to individual sections for specific Shop Drawing requirements for building enclosure products and equipment. Show interfaces and relationship of components shown on separate Shop Drawings.
 2. Include details of treatment of penetrations in building envelope by work of other Sections.
 3. Show dimensions and clearances of interrelated building enclosure work.
 4. Indicate required installation sequences of interrelated building enclosure work.
 5. Include information necessary for interface with other building components.
- D. Compatibility Compliance Letter: Manufacturer to provide a letter of compliance for compatibility and adherence with the substrate on which it is to be applied.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Manufacturer, Installer, and Testing Agency.
- B. Product List: Provide list of products to be incorporated in air barrier work and to serve as substrates for air barrier work. Indicate products of separate manufacturers that will be in contact with one another. Submit manufacturer's certificates indicating products as proposed are compatible.

- C. Product Certificates: For insulating air barriers, certifying compatibility of air barrier and accessory materials with Project materials that connect to or that come in contact with the barrier; signed by product manufacturer.
 - 1. Coordinate with preconstruction compatibility testing requirements in Section 079200 "Joint Sealants."
 - D. Qualification Data: For Applicator.
 - E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers.
 - F. Substrate Examination Report.
 - G. Inspection Reports: Daily reports of testing agency and reports of manufacturer's technical representative. Include weather conditions, description of work performed, tests performed, defective work observed, and corrective actions taken to correct defective work.
- 1.7 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A listed primary manufacturer of air barrier materials of type specified in this Section and meeting descriptive and performance requirements, that employs technical representatives who are trained and approved to perform field quality control inspections.
 - 1. Manufacturer must have qualified NFPA 285 testing meeting performance requirements of this section at time of bidding.
 - B. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single approved manufacturer.
 - C. Applicator Qualifications: A firm experienced in applying insulating air barrier materials 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.
 - D. Installer Qualifications: A firm experienced in applying insulating air barrier materials 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, that employs experienced installers and supervisors who are trained and approved by manufacturer, with a record of successful installations on projects of similar scope.
 - 1. Installer shall be approved by manufacturer for application of manufacturer's materials for this Project.
 - 2. Installer's full-time on-site supervisor shall have a minimum of five years' experience installing similar work, able to communicate verbally with Contractor, Architect, testing agency, and employees.
 - E. Source Limitations: Obtain insulating air barrier materials through one source, from or approved by the spray-applied insulation manufacturer.

- F. Mockups: Provide air barrier application within mockups required in other sections identical to specified products and installation methods, to establish quality standards for finished work.
 - 1. Build integrated mockups of exterior wall assembly incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before cladding is installed.
 - b. Include junction with roofing membrane, building corner condition and foundation wall intersection.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air barrier manufacturer.
- B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- C. Store rolls according to manufacturer's written instructions.
- D. Protect stored materials from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Apply insulating air barrier within the range of ambient and substrate temperatures recommended by insulating 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.

1.10 COORDINATION

- A. Coordinate application of spray-applied insulating air barriers and building cladding to ensure that finished installation is not exposed to weather for longer period of time than recommended in writing by insulating air barrier manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. Low-Emitting Materials: Air barriers 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."

2.2 PERFORMANCE REQUIREMENTS

- A. General: Insulating air barrier shall be capable of performing as a continuous thermally insulating air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Insulating air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum **0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.**, when tested according to ASTM E 783.
- C. Fire Performance: Provide spray-applied insulating air barriers and accessory materials that are tested for compliance with NFPA 285 when used as part of an exterior wall assembly identical to that required for Project.
 - 1. When testing of identical wall assembly is not available, provide engineering judgment by qualified third party testing agency acceptable to authorities having jurisdiction demonstrating compliance with requirements.

2.3 SPRAYED INSULATION/AIR BARRIER

- A. Spray Foam Insulation: Two-component, closed-cell spray-applied rigid polyurethane foam, suitable for intended application and compatible with cavity wall substrates, with zero ozone depletion potential blowing agents, formulated from rapidly-renewable resource base material, with the following characteristics:
 - 1. Thermal Resistance, ASTM C 518: Not less than 6.7 sq. ft/hr x deg. F/BTU in., at 2 days at 73.4 deg F.
 - 2. Membrane Air Permeance: ASTM E 2178: Not to exceed **0.004 cfm x sq. ft. of surface area at 1.57-lbf/sq. ft.** pressure difference.
 - 3. Membrane Vapor Permeance: ASTM E 96: Not to exceed **0.1 perm.**
 - 4. Surface Burning Characteristics, ASTM E 84: Flame Spread: Less than 25; Smoke Developed: Less than 450.
 - 5. Density, ASTM D 1622: 2.0 lb/sq. ft, at core, minimum.
 - 6. Water Absorption, ASTM D 2842: 1.0 percent by volume, maximum.
 - 7. Fungi Resistance: ASTM C 1338: No fungal growth.
 - 8. Manufacturer/Product: Provide one of the following:
 - a. Huntsman Building Solutions, The Woodlands TX, (855) 742-7227, [ProSeal](#) (basis of design).
 - b. BASF Polyurethane Foam Enterprises, LLC., (800) 796-9743, [Walltite Insulating Air Barrier](#).
 - c. LaPolla Industries, Inc., [Foam-Lok AB2000](#).
 - d. Johns Manville, [JM Corbond IV](#).

2.4 AUXILIARY MATERIALS

- 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.

1. Provide compatible auxiliary materials in contact with spray-applied insulating air barriers, including transition materials and cavity closure flashing indicated on drawings and as additionally required to provide complete airtight construction.
- B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of air barrier material.
- C. Thermal Barrier: Where required for compliance with fire performance requirements: Manufacturer's tested topcoat consisting of intumescent coating suitable for application, applied in thickness required to meet requirements, at spray-applied insulation thickness specified for Project.
- D. Transition Assembly: Silicone rubber extrusion sheet and premolded corners extruded with lock-in dart fitted to extruded aluminum adapter configured for attachment or capture to window, storefront, curtainwall, and louver framing, providing permanent flexible seal between aluminum framed openings and adjacent field of air barrier wall installation. Provide with assembly and air barrier manufacturer's recommended sealant tapes and liquid sealants compatible with adjacent materials.
- E. Counterflashing Strip: Modified bituminous, 40-mil-thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil-thick, cross-laminated polyethylene film with release liner backing.
- F. Modified Bituminous Strip: Vapor-retarding, 40-mil-thick, smooth-surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick polyethylene film with release liner backing.
- G. Joint Reinforcing Strip: Air barrier manufacturer's glass-fiber-mesh tape.
- H. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- I. Adhesive and Tape: Air barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- J. Sprayed Polyurethane Foam Sealant: 1- or 2-component, foamed-in-place, polyurethane foam sealant, 1.8 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.
- K. Modified Bituminous Transition Strip: Vapor-retarding, 40-mil-thick, smooth-surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick polyethylene film with release liner backing.
- L. Elastomeric Flashing Sheet: ASTM D 2000, 2BC415 to 3BC620, minimum 50- to 65-mil-thick, cured sheet neoprene with manufacturer's recommended contact adhesives and lap sealant with aluminum termination bars and stainless-steel fasteners.
- M. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

- N. Compressible Filler: Preformed foam insulation, 2 inches thick unless otherwise indicated, compressible to 50 percent of thickness, and compatible with air barrier system components, for application at building movement joints.
- O. Spray Stop: Extruded plastic angles, minimum 0.060-inch thick by depth of applied foam insulation, of profile indicated on Drawings.
 - 1. Basis of design product: Exo-Tec Manufacturing, Inc., Jam-Ex; www.exo-tec.biz.
 - 2. Paul Murphy Plastics, Co., X10055; <https://paulmurphyplastics.com/>
 - 3. United States Plastic Corp., 45031 Extruded Angle; <https://www.usplastic.com/>
- P. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 50, Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section "Joint Sealants," and compatible with adjacent materials.

PART 3 - EXECUTION

3.1 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. Verify that concrete has cured and aged for minimum time period recommended by air barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 4. Verify that wood nailers and blocking to receive application of self-adhering transition material meet transition material manufacturer's requirements for dryness.
 - 5. Verify that masonry joints are flush and completely filled with mortar.
 - 6. Verify that veneer anchors are in place.
 - 7. Verify that penetrating items are in place.
 - 8. Submit written report of examination.
 - 9. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate meeting manufacturer's requirements for application of insulating air barrier.
- B. Mask off adjoining surfaces not covered by insulating air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

- F. 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.
- G. 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 and covered with self-adhering transition material to provide continuous support for air barrier.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare and fill joints and cracks in substrate according to ASTM C 1193 and air barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply a single thickness of preparation coat strip extending along each side of joints and cracks. Apply a double thickness of air barrier membrane and embed a joint reinforcing strip in preparation coat.
 - 2. Place compressible joint filler at building movement joints and adhere with recommended adhesive.
- B. Gypsum Sheathing: Fill joints with sealant according to ASTM C 1193 and with air barrier manufacturer's written instructions. Apply first layer of fluid air barrier membrane at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air barrier membrane over joint reinforcing strip.

3.4 TRANSITION STRIP INSTALLATION

- A. Install strips, transition strips, flashing strips, spray stops, and other auxiliary materials according to insulating air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of insulating air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
- B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by insulating air barrier in same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall insulating air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of insulating air barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

- F. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply adhesive-coated transition strip so that a minimum of **3 inches** of coverage is achieved over both substrates. Maintain **3 inches** of full contact over firm bearing to perimeter frames with not less than **1 inch** of full contact.
1. Adhesive-Coated Transition Strip: Roll firmly to enhance adhesion.
 2. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at **6 inches** o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
 3. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and membrane.
 4. Opening Transition Assembly: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply opening transition assembly so that a minimum of **3 inches** of coverage is achieved over insulation substrate. Maintain not less than **1 inch** of full contact to perimeter frames through adhesion or clamping.
- G. Spray Stops: Apply spray stops in accordance with details on Architectural Drawings.
- H. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.
- I. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- J. Seal top of through-wall flashings to air barrier with an additional **6-inch**-wide, modified bituminous strip.
- K. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- L. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending **6 inches** beyond repaired areas in strip direction.

3.5 SPRAY-APPLIED INSULATING AIR BARRIER MEMBRANE INSTALLATION

- A. Apply insulating air barrier membrane to form a seal with strips and transition strips and to achieve a continuous air barrier according to air barrier manufacturer's written instructions.
- B. Apply air barrier membrane within manufacturer's recommended application temperature ranges.
- C. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.
1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- D. Apply the sprayed insulation to average thickness and minimum thickness indicated on Drawings, or if not indicated, to average thickness of 3-1/2 inches and minimum thickness of 3 inches. Apply the average full thickness no less & no more than 1/4 inch of thickness specified. Typical thickness variation for closed-cell spray foam can be 1/2" maximum.

- E. Apply 6-inch width of sprayed insulation at 1 inch thick around perimeter of flashed openings and at perimeter of application and allow to form initial set prior to applying sprayed insulation in field of wall, for purpose of preventing insulation shrinkage stress to deform edge flashing materials or result in open shrinkage cracks. Presence of shrinkage cracks will be considered evidence of defective application.
- F. Apply strip and transition strip over cured air membrane overlapping **3 inches** onto each surface according to air barrier manufacturer's written instructions.
- G. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- H. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.
- I. Where required, apply thermal barrier coating to spray-applied insulating air barrier in thickness required by approved tests.
- J. When necessary these materials can be trimmed to accommodate application of a finish material or to ensure adequate air space within the cavity.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections in addition to Owner's testing that is necessary to ensure compliance with requirements.
- C. Inspections: Insulating air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 - 1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Continuous structural support of air barrier system has been provided.
 - 3. Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions, and mortar droppings.
 - 4. Site conditions for application temperature and dryness of substrates have been maintained.
 - 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
 - 6. Surfaces have been primed, if applicable.
 - 7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 - 8. Termination mastic has been applied on cut edges.
 - 9. Strips and transition strips have been firmly adhered to substrate.
 - 10. Compatible materials have been used.
 - 11. Transitions at changes in direction and structural support at gaps have been provided.
 - 12. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal.
 - 13. All penetrations have been sealed.

- D. Manufacturer's Technical Representative: Engage a qualified manufacturer's technical representative to participate in Quality Assurance and Quality Control activities, including Preinstallation Meeting, startup, interim inspections, and completion inspections, and to prepare reports.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
 - 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION

- A. Protect insulating air barrier system from 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.
 - 2. Protect air barrier from contact with creosote, uncured coal-tar products, TPO, EPDM, flexible PVC membranes, and sealants not approved by insulating air barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION 07 27 29

SECTION 07 42 13 - METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Prefinished factory-formed and field-assembled, concealed-fastener, lap-seam smooth surface metal wall panels.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Capable of withstanding the effects of gravity loads and the following loads and stresses, based on testing according to ASTM E 1592 & ASTM E 330:

1. Wind Loads: Minimum design wind pressure as indicated on structural drawings, acting inward or outward or if not indicated, as required by local code.
2. Deflection Limits: Withstand test pressures with deflection no greater than 1/240 of the span and no evidence of material failure, structural distress, or permanent deformation exceeding 0.2 percent of the clear span.

B. Seismic Performance: Provide metal wall panel assemblies capable of withstanding the effects of earthquake motions determined according to local code requirements.

1.3 SUBMITTALS

A. Product Data: For each type of metal wall panel and accessory indicated.

B. Shop Drawings: Show layouts of metal wall panels, including plans, elevations, sections, details, and attachments to other work.

1. Include details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories.

C. Samples: For each exposed finish, in 12'x12" sizes minimum.

D. Material certificates.

E. Product test reports.

F. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Installer's responsibilities include fabricating and installing metal wall panel assemblies and providing professional engineering services needed to assume engineering responsibility.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Final Acceptance.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: subject to compliance with requirements, provide products by one of the following:
 - 1. Petersen Architectural Corp.
 - 2. Morin, a Kingspan Group Company
 - 3. CENTRIA

2.2 PANEL MATERIALS

- A. Face Sheet Material: Aluminum per ASTM B-209, US Mill of Manufacture and Aluminum shall be tension leveled (temper passed and stretcher leveled) with camber a maximum of 1/4 inch in 20 feet, manufactured in the USA, and be standard thickness of .050" Aluminum Gage
 - 1. Surface: Smooth, flat finish.
 - a. High-Performance Organic Finish: Two-coat, thermocured system with fluoropolymer coats containing not less than 70 percent polyvinylidene fluoride resin by weight. Manufacturer's custom color to match Pac-Clad "Weathered Zinc" color.
 - 2. Concealed Finish: White or light-colored acrylic or polyester backer finish.
- B. Panel Sealants:
 - 1. Sealant Tape: Provide two part polysulfide class "B" non-sag type for vertical and horizontal joints, brand name: NP-1, Geocell 2300, Weathermaster "Titebond" or similar performing caulking.
 - 2. One part polysulfide not containing pitch or phenolic extenders, or;
 - 3. Exterior grade silicone sealant recommended by roofing manufacturer, or;

4. One part non-sag, gun grade, exterior type polyurethane recommended by roofing manufacturer.

2.3 SUBSTRATE BOARDS

- A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M; regular, 5/8 inch (13 mm) thick.
- B. Substrate-Board Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to substrate.

2.4 RAINSCREEN ATTACHMENT SYSTEM (CI SYSTEM)

- A. Provide a thermally broken, rainscreen attachment system for attachment of exterior metal cladding installed over continuous exterior-insulation.
 1. Provide products equal to Knight Wall System
- B. See drawings.
- C. Design Requirements:
 1. Manufacturer is responsible for designing system, including anchorage to structural system and necessary modifications to meet specified requirements and maintain visual design concepts.
 2. Employ registered professional engineer, licensed to practice engineering in jurisdiction where Project is located, to engineer each component of rainscreen attachment system.
 3. Structural Design: Exterior-insulated rainscreen wall assembly capable of withstanding effects of load and stresses from dead loads, wind loads, ice loads (if applicable) as indicated on Structural General Notes on Structural Drawings, and normal thermal movement without evidence of permanent defects of assemblies or components.
 - a. Thermal Movements: Provide assemblies that allow for thermal movements resulting from the following maximum ambient temperatures by preventing overstressing of components and other detrimental effects:
 - 1) Temperature Change (range): 120 degrees Fahrenheit (67 degrees C), ambient:
 4. Support Framing/Attachment System:
 - a. No framing component may penetrate the layer of continuous exterior insulation other than thermally isolated fasteners.
 - b. Frequency and spacing of stiffened vertical girts as indicated by manufacture in project specific engineering package.

2.5 LAP-SEAM HORIZONTAL METAL WALL PANELS

- A. Concealed-Fastener with Clip, Lap-Seam Metal Wall Panels: Factory-formed, designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
1. Available Manufacturers:
 - a. Petersen Aluminum Corporation (Basis of Design: Highline B1)
 - b. Morin, a Kingspan Group Company
 - c. CENTRIA
 2. Highline B1: Horizontal corrugated smooth ribbed panel as indicated on Drawings.
 - a. 1-3/8" high
 - b. 11.365" width
 - c. Lengths up to 22'
 3. Material: 24 ga. steel.
 - a. Exterior Finish: Fluoropolymer.
 - b. Color: Manufacturer's premium 2 coat fluoropolymer as selected from manufacturer's standard colors.
 4. Panel dimensions as indicated on Drawings.

2.6 ACCESSORIES

- A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.
1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
 2. Closure Strips: Use composition or metal profiled closures at top of each elevation to close ends of the panels. Metal closures to be made in the same material and finish as face sheet. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Trim fabricated of the same material and finish profiled sheeting and press broken in lengths of 10 to 12 feet. Trim shall be formed only by the manufacturer or their approved dealer. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.7 FABRICATION

- A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated

performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

- B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- C. Where indicated, fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
- D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
- E. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install flashings and other sheet metal to comply with requirements specified in Division 07 Section "Flashing and Sheet Metal."
- B. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

3.2 METAL WALL PANEL INSTALLATION, GENERAL

- A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to furring, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cutting of metal wall panels by torch is not permitted.
 - 2. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 5. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
 - 6. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- B. Fasteners:
 - 1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.

- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.
 - 1. Coat back side of aluminum wall panels with bituminous coating where wall panels will contact wood, ferrous metal, or cementitious construction.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies.
 - 1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Sealants."

3.3 FIELD-ASSEMBLED METAL WALL PANEL INSTALLATION

- A. Lap-Seam Metal Wall Panels: Fasten metal wall panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
 - 1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation.
 - 2. Provide concealed fastener system.
 - 3. Provide sealant tape at lapped joints of metal wall panels and between panels and protruding equipment, vents, and accessories.
 - 4. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps, and on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weatherproof to driving rains.
 - 5. At panel splices, nest panels with minimum 6-inch (150-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

3.4 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 2. Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed 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 weather resistant.

3.5 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

END OF SECTION 07 42 13

SECTION 07 42 43 - COMPOSITE WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes metal-faced composite wall panels.
 - 1. Panel system requirements include the following components:
 - a. Aluminum faced composite panels with mounting system. Panel mounting system including anchorages, shims, furring, fasteners, gaskets and sealants, related flashing adapters, and masking (as required) for a Pressure Equalized Rain Screen II System.
 - b. Parapet coping, column covers, soffits, sills, border, and filler items indicated as integral components of the panel system or as designed.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure of 30 lbf/sq. ft. acting inward or outward.
 - 2. Deflection Limits: Metal-faced composite wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/175 of the span at the perimeter and 1/60 of the span anywhere in the panel of the span.
 - 3. Pressure Equalized Rain Screen Systems shall comply with AAMA 508-05 Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation layouts of metal-faced composite wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.

- C. Samples: For each type of exposed finish required.
- D. Delegated-Design Submittal: For metal-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data and calculations signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other.
- F. Product test reports.
- G. Maintenance data.
- H. Samples of special warranties.

1.4 QUALITY ASSURANCE

- A. Fire-Resistance Ratings: Where indicated, provide metal-faced composite wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Preinstallation Conference: Conduct conference at Project site.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Final Acceptance.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal-faced composite wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Finish Warranty Period: 20 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

- A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 - 1. Surface: Smooth, flat finish
 - 2. Exposed Anodized Finishes:

- a. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
 3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- B. Panel Sealants: ASTM C 920.

2.2 MISCELLANEOUS METAL FRAMING

- A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653, G60 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.
- B. Subgirts: Manufacturer's standard C- or Z-shaped sections 0.064-inch nominal thickness.
- C. Zee Clips: 0.079-inch nominal thickness.
- D. Base or Sill Angles or Channels: 0.079-inch nominal thickness.
- E. Hat-Shaped, Rigid Furring Channels:
 1. Nominal Thickness: As required to meet performance requirements.
 2. Depth: 1-1/2 inches.
- F. Cold-Rolled Furring Channels: Minimum 1/2-inch- wide flange.
 1. Nominal Thickness: As required to meet performance requirements.
 2. Depth: 3/4 inch .
 3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch.
 4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

2.3 MISCELLANEOUS MATERIALS

- A. Aluminum Extrusions: ASTM B 221.
- B. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal-faced composite wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.4 METAL-FACED COMPOSITE WALL PANELS

- A. General: Provide factory-formed and -assembled, metal-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system

components and accessories required for Pressure Equalized Rain Screen II System: System must provide air/vapor barrier as indicated in AAMA 508-05.

1. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Alcan Composites USA Inc.; Alucobond, Plus - FR Core
 - b. Alcoa Inc.; Reynobond FR
 - c. ALPOLIC, Division of Mitsubishi Chemical America, Inc.;
 - d. CENTRIA Architectural Systems;
- B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- (0.50-mm-) thick, anodized aluminum sheet facings.
1. Panel Thickness: 0.157 inch (4 mm)
 2. Core: Standard Thermo-set, High density polyurethane
 3. Exterior Finish: 2-coat Mica fluoropolymer
 - a. Color: Selected by Architect from manufacturer's full range.
- C. Attachment System Components: Formed from extruded aluminum or material compatible with panel facing.
1. Include manufacturer's standard perimeter extrusions with integral weather stripping, panel stiffeners, panel clips, and anchor channels.

2.5 ACCESSORIES

- A. Wall Panel Accessories: Provide components required for a complete metal-faced composite wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal-faced composite wall panels unless otherwise indicated.
- B. Flashing and Trim: Formed from 0.018-inch- minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal-faced composite wall panels.

2.6 FABRICATION

- A. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to

fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

- B. Fabricate metal-faced composite wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- C. Metal-Faced Composite Wall Panels: Factory form panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.
 - 1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
 - 2. Fabricate panels with sharply cut edges, with no displacement of face sheets or protrusion of core material.
 - 3. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
 - 4. Dimensional Tolerances:
 - a. Panel Bow: 0.8 percent maximum of panel length or width.
 - b. Squareness: 0.25 inch maximum.
- D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal-faced composite wall panel manufacturer's written instructions.

3.2 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

- A. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
 - 1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
 - 2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.

3.3 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed 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 weather resistant.

3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.
- B. After metal-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

END OF SECTION 07 42 43

SECTION 07 51 00 – MODIFIED BITUMEN ROOFING

PART 1 - GENERAL

1.1 GENERAL NOTES

- A. Contractor will perform all work by competent, trained, and properly equipped personnel in strict accordance with good roofing practices and applicable industry standards.
- B. Contractor will observe all published safety prevention policies and practices relating to application of roofing system and related work. All federal, state, and local codes shall be followed.

1.2 SUMMARY

- A. This Section includes the following:
 - Install Specified ISO and Coverboard in DUOTACK 365 insulation adhesive (12-6-4” O/C).
 - Torch Apply SBS Field Base Ply (SOPRALENE FLAM 180).
 - Torch Apply SBS Field Cap Membrane (SOPRALENE FLAM 250 FR GR).
 - Torch Apply SBS Flashing Base Ply (SOPRALENE FLAM 180).
 - Torch Apply SBS Flashing Cap Membrane (SOPRALENE FLAM 250 FR GR).
 - Assure roof contractor is an approved/certified contractor to install SOPREMA roof systems.
 - Follow SOPREMA details/installation requirements to assure compatibility with tie in to existing warranted roof system.
- B. Related Sections include the following:
 1. Division 06 Section “General Carpentry”.
 2. Division 07 Section “Sheet Metal Flashing and Trim”.
 3. Division 07 Section “Sealants”.
 4. Division 01 Section “ Submittal Procedures”

1.3 REFERENCES:

- A. Refer to the following references for specification compliance:
 1. Asphalt Roofing Manufacturers Association - ARMA
 2. Factory Mutual System - FM
 4. National Roofing Contractors Association – NRCA – Roofing and Waterproofing Manual
 5. Underwriters Laboratories, Inc. – UL
 6. Sheet Metal Air Conditioning Contractors National Association, Inc. – SMACNA – Architectural Sheet Metal Manual.
 7. MRCA 1986 – Safety in torch welding modified bitumen roofing.

- B. Refer to ASTM D 1079 for definitions of terms related to roofing work not otherwise defined in this section.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Install a watertight, UL 790 Class A, multiple ply asphalt elastomer membrane roof system including flashing system and all accessories with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

1.5 SUBMITTALS:

- A. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work, for the following:
 - 1. Base flashings, cants, and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Crickets, saddles, and tapered edge strips, including slopes.
 - 4. E.I.P. membrane flashing on parapet walls
 - 5. Roof system manufacturer's prescribed fastening patterns for field, perimeter and corner areas of each roof section necessary to comply with the wind uplift design requirements.
- C. Samples for Verification: Of the following products:
 - 1. 12-by-12-inch square of each membrane sheet, of color specified.
 - 2. 12-by-12-inch square of roofing insulation.
 - 3. 12-by-12-inch square of each type of walkway pad.
 - 4. All other miscellaneous components of the system.
 - 5. Roof penetration flashing
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing system and is eligible to receive the standard roofing manufacturer's warranty and meets the requirements specified in the "Quality Assurance" Article.
- E. Manufacturer Certificates: Signed by roofing system manufacturer certifying that the roofing system complies with requirements specified in the "Performance Requirements" Article. On request, submit evidence of complying with requirements.
- F. Qualification Data: For firms and persons specified in the "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.
- G. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of components of roofing system with requirements based on comprehensive testing of current product compositions.

- H. Maintenance Data: For roofing system to include in the maintenance manuals specified in Division 01. Include the following:
 - 1. Roofing manufacturer's recommendations for preventive and routine maintenance.
 - 2. A schedule for periodic roof inspections and repair, including:
 - a. Inspection at least twice a year, preferably in the spring and fall.
 - b. Inspection after severe weather or storms and removal of all debris from roof.
- I. Warranty: Sample copy of roofing system manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty. All items listed under the Part 1 Article "Warranty" shall also be addressed.
- J. Inspection Reports: Copy of roofing system manufacturer's inspection reports for each week of roof installation and of completed roofing installation.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer with 5 years experience under the awarded roofing sub-contractor to perform Work of this Section who has specialized in installing roofing similar to that required for this Project; who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product; and who is eligible to receive the standard roofing manufacturer's warranty. Additionally, roofing applicator shall have the experience of 5 similar roof projects. Roofing applicator shall have at least one (1) million dollar insurance liability umbrella. Verification shall be provided to the Architect upon request. Contractor shall have an EMR of .9 or less for 3 years on average and no one year above 1.
- B. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method indicated below by UL, FM, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; complying with ASTM E 108, for application and slopes indicated.
- C. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site. Meet with the same participants and review the same items listed for the preinstallation conference. In addition, review status of submittals and coordination of work related to roof construction. Notify participants at least 5 working days before conference.
- D. Preinstallation Conference: Before installing roofing system, conduct conference at Project site to comply with requirements of Division 01. Notify participants at least 5 working days before conference.
 - 1. Meet with Owner; Architect; Owner's insurer, and roof manufacturer representative; 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. With Architect and Owner, examine deck substrate conditions and finishes for compliance with requirements, including flatness and attachment to structural members.
 4. Review loading limitations of deck during and after roofing.
 5. Review flashings, special roofing details, exterior and interior roof drainage, roof penetrations, equipment curbs, parapet conditions / transitions and condition of other construction that will affect roofing.
 6. Review governing regulations and requirements for insurance, certifications, and inspection and testing, if applicable.
 7. Review temporary protection requirements for roofing system during and after installation.
 8. Review roof observation and repair procedures after roofing installation.
 9. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.
- E. Contractor shall schedule the roof system manufacturer's technical representative to be present for the pre-construction meeting and to inspect work completed once each week and as otherwise requested throughout the Project and upon Substantial Completion. This includes during critical roofing operations such as the first day of roofing installation, first day of flashing installation, and the first day of cap sheet installation. Manufacturer shall generate reports from these site inspections and supply the Architect copy of same.
- F. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or as approved by membrane roofing manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing materials in a dry, warm, well-ventilated, weathertight location according to roofing system manufacturer's written instructions. Store sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.
1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
- B. Do not leave sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 deg F.
- C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturers written instructions for handling, storing, and protecting during installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.

- B. Protect against staining and mechanical damage of adjacent surfaces and work areas during application. Staining, mechanical damage, or discoloration of the membrane shall be cause for rejection.

1.9 WARRANTY

- A. General Warranty: The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents, Uniform Commercial Code regulations or applicable state statutes of limitations. This warranty shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Standard Roofing Manufacturer's Warranty: Submit a written warranty, without deductible and without monetary limitation, signed by roofing system manufacturer agreeing to promptly repair leaks in the roofing system resulting from defects in materials or workmanship for the following warranty period:
 - 1. Warranty Period: 20 years from date of Final Acceptance. (no dollar limit system warranty provided by the roofing system manufacturer).
 - a. This warranty shall be non-prorated and fully transferable to new building Owner within the original warranty period.
- C. Special Project Warranty: Submit a written warranty, without deductible and without monetary limitation, signed by roofing system installer, covering the Work of this Section, including roof membrane, base flashing, E.I.P. membrane flashing, counterflashing, roof insulation, tapered edge and cant strips, metal edging, fasteners, mastics, adhesives, and all components required for a complete roof system installation, for the following warranty period:
 - 1. Five Year Warranty: Upon completion of the Work, a guarantee covering all work performed under this Section provides that for a period of five (5) years from date of Final Acceptance., the roofing system installer shall (at his or her own expense) maintain the Work performed in a watertight condition and correct any defects which may develop, including but not limited to, blisters, wrinkles, ridges, splits, warped insulation and loose flashings, in such a way as to restore the Work to a condition comparable to that at date of Final Acceptance. Guarantee shall include installer's agreement to perform emergency repairs within 24 hours notice of an observed leak and to perform permanent repairs within 30 days thereafter.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Roofing system shall be as manufactured by SOPREMA, Siplast, GAF, or approved equivalent. Contractor to ensure system meets the requirements of this specification inclusive of approval agencies and manufacturers warranty requirements. Roofing system shall consist of:
 - 1. Temporary Roof/Vaper Retarder Membrane (Torch Applied): Glass or polyester reinforced SBS asphalt sheet having a minimum weight of 75 pounds/square, type

SOPREMA ELASTOPHENE SP 3.0, Siplast Paradiene 20, GAF Mop Plus Smooth or approved equivalent.

2. Field Base Ply (Torch Applied): SBS modified reinforced cap sheet with factory applied granule protection and manufactured for cold adhesive application.
 - a. SOPREMA SOPRALENE FLAM 180
 - b. Siplast Paradiene 30 FR
 - c. GAF Mop Plus Granule FR
 4. Field Cap Membrane (Torch Applied): SBS modified reinforced cap sheet with factory applied granule protection and manufactured for cold adhesive application.
 - a. SOPREMA SOPRALENE FLAM 250 FR GR
 - b. Siplast Paradiene 30 FR
 - c. GAF Mop Plus Granule FR
- B. Flashing shall consist of:
1. Flashing Base Ply: Granule surfaced, asphalt elastomer glass reinforced sheet of 86 pounds/square minimum weight, type SOPREMA SOPRALENE FLAM 180, Siplast P30FR or GAF Mop FR.
 2. Flashing Cap Membrane: Glass reinforced asphalt sheet of 75 pounds/square minimum weight, type SOPREMA SOPRALENE FLAM 250 FR GR, Siplast P20 or GAF Mop Smooth.
 3. Fully Adhered Parapet Wall Flashing Membrane: Flashing membrane shall be 0.045 inch thick ethylene interpolymer (E.I.P.) alloy, reinforced with knitted polyester fabric. Product shall be compatible with roofing and roof flashing system. Installer shall be responsible to prepare the substrate for the correct application of his product and use the recommended adhesives for his product to insure a warrantable installation. See Drawings for details. Acceptable manufacturers:
 - a. Seaman Corporation "FiberTite-XT" or approved substitute.
- C. Insulation Fasteners – heavy duty threaded fastener with 3-coat waterborn fluorocarbon polymer coating and drill point tip capable of penetrating steel deck. Fastener shall meet minimum thread size of 0.26 inch and 13 threads per inch. Length shall be sufficient to penetrate deck a minimum of 3/4 inch. Fasteners must be approved by the membrane manufacturer for inclusion in warranty.
- D. Asphalt primer to meet ASTM D-41. Primer must be approved for intended use by membrane manufacturer.
- E. Roof cement: To be asbestos free SBS polymer modified trowel grade asphaltic cement. Roof cement must be approved for intended use by membrane manufacturer.
- F. Ceramic granules of color scheme matching the granule surfacing of the cap sheet comparable to 3M No. 11 granules.
- G. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

- H. Roof walkway pads: Provide 18" x 18" SBS granule surface sheet, torched to finished roof surface. Remove smooth, selvage edge if left exposed.
- I. Repelling concrete pads: Provide 18" x 18" precast concrete roof pads where indicated on Drawings. Install regular roof walkway pads as noted above under concrete pads for roof protection.

2.2 ROOF INSULATION MATERIALS:

- A. General: Provide preformed, roofing insulation boards that comply with requirements, selected from manufacturer's standard sizes and of thickness indicated. Provide tapered panels where indicated and as required to shed water around mechanical units and other obstacles.
- B. Polyisocyanurate Board Insulation: Provide closed cell rigid, cellular polyisocyanurate thermal insulation (reference drawings for thickness) complying with ASTM C 1289, with a minimum R-factor of R-7.2/inch. Insulation shall have a perforated black glass reinforced mat laminated to the face. Insulation board must be approved by roof system manufacturer.
- C. Coverboard: as indicated on the drawings.
- D. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer for intended use.

2.3 INSULATION ACCESSORIES

- A. General: Furnish roofing insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates, designed for fastening roofing insulation to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
- C. Tapered Edge Strips: Rigid, glass-fiber insulation board, complying with ASTM C 726.
- D. Substrate Joint Tape: 6 or 8 inches wide, coated, glass-fiber joint tape.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. A pre-job conference including the Architect, Contractor, and the membrane manufacturer's representative shall be conducted prior to the application of the roofing.
- B. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements.
- C. Verify that roof openings and penetrations are in place and set and braced.

- D. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at roof penetrations and terminations and match the thickness of insulation required.
 - 1. Verify that wood nailer strips are located perpendicular to roof slope and spaced according to requirements of roofing system manufacturer.
- E. Verify that flatness and fastening of metal roof decks comply with installation tolerances specified in Section 05 31 00 "Steel Decking".
- F. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Insulation and base sheet substrates shall present a smooth surface to accept the roof membrane. Ensure adequate curing time prior to commencement of membrane application.
- C. Prevent materials from spilling or migrating onto surfaces of other construction.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install multiple ply asphalt elastomer membrane roof system according to roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-Up Roofing."
 - 1. Install roofing system according to applicable specification plates of NRCA's "The NRCA Roofing and Waterproofing Manual."
- B. Cant Strips: Install and secure preformed 45-degree cant strips at junctures of multiple ply asphalt elastomer membrane roof system with vertical surfaces or angle changes greater than 45 degrees.
- C. Cooperate with inspecting and testing agencies engaged or required to perform services for installing multiple ply asphalt elastomer membrane roof system.
- D. Coordinate installing roofing system components so insulation and roofing plies are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast.
 - 1. Provide cutoffs at end of each day's work to cover exposed ply sheets and insulation with a course of coated felt with joints and edges sealed.
 - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 - 3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

- B. Comply with roofing system manufacturer's written instructions for installing roofing insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated and to comply with Shop Drawings.
- D. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- E. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 3 inches or greater, install required thickness in 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- F. Install insulation with long joints of insulation in continuous straight lines 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. Attached Insulation: Secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roofing insulation to deck type indicated. Set each subsequent layer of insulation in cold-applied insulation adhesive.
 - 1. Fasten insulation according to the insulation and roofing system manufacturers' written instructions.

3.5 ROOF SYSTEM INSTALLATION

- A. General: Application shall be in accordance with the roofing system manufacturer's instructions and the following requirements. Application of roofing shall immediately follow application of insulation as a continuous operation.
- B. Install base sheet fasteners as recommended by roof system manufacturer's recommendations or minimum 9 inches on center in all directions.
- C. Apply roofing in accordance with roofing system manufacturer's instructions and the following requirements. Application of the roofing membrane base ply shall immediately follow application of base sheet as a continuous operation.
- D. AESTHETIC CONSIDERATIONS: An aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this project. Make necessary preparations, utilize recommended application techniques, apply the specified materials (i.e. granules, etc.), and exercise care in ensuring that the finished application is acceptable to the Owner. Excessive footprints or impressions in the surface ply will be grounds for rejection thereby requiring complete membrane tear-off and replacement.
- E. PRIMING: Prime metal flanges and concrete and masonry surfaces with a uniform coating of ASTM D41 asphalt primer. Prime concrete deck prior to heat welded (torch) application of ELASTOPHENE SP 3.0.
- F. HEAT WELDED, FULLY ADHERED VAPOR RETARDER/TEMPORARY ROOF APPLICATION: Follow material product data sheets and published general requirements for

installation instructions. Ensure environmental conditions are safe and satisfactory, and will remain safe and satisfactory, during the application of the heat-welded vapor retarder membrane. Ensure all primers are fully dry before beginning heat-welding operations. Unroll membrane onto the roof surface and allow time to relax prior to heat welding. Starting at the low point of the roof, lay out the membrane to ensure the plies are installed perpendicular to the roof slope, shingled to prevent back-water laps. Ensure all roofing and flashing substrates are prepared and acceptable to receive the heat-welded membrane. Cut membrane to working lengths and widths to conform to rooftop conditions, and lay out to always work to a selvage edge. Ensure specified side-laps and end-laps are maintained. End-laps should be staggered 3 ft apart. Direct roof torch on the roll as necessary to prevent overheating and damaging the membrane and substrates. As the membrane is unrolled, apply heat to the underside of the membrane until the plastic burn-off film melts away. Continuously move the torch side-to-side across the underside of the roll to melt the bitumen on the underside of the sheet, while continuously unrolling the membrane. While unrolling and heating the sheet, ensure a constant flow hot bitumen approximately $\frac{1}{4}$ to $\frac{1}{2}$ in flows ahead of the roll as it is unrolled, and there is $\frac{1}{8}$ to $\frac{1}{4}$ in bleed out at all laps. Adjust the application of heat to the underside of the membrane and to substrate as required for varying substrates and environmental conditions. At end-laps, cut a 45 degree dog-ear away from the selvage edge, or otherwise ensure the membrane is fully heat-welded watertight at all T-joints. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight. Where necessary, use a torch or hot-air welder and a clean trowel to ensure all laps are fully sealed. Inspect the installation each day to ensure the plies are fully adhered. Repair all voids, wrinkles, open laps and all other deficiencies.

- G. **HEAT WELDED, FULLY ADHERED MEMBRANE APPLICATION:** Follow material product data sheets and published general requirements for installation instructions. Ensure environmental conditions are safe and satisfactory, and will remain safe and satisfactory, during the application of the heat-welded membrane and flashings. Ensure all primers are fully dry before beginning heat-welding operations. Unroll membrane onto the roof surface and allow time to relax prior to heat welding. Starting at the low point of the roof, lay out the membrane to ensure the plies are installed perpendicular to the roof slope, shingled to prevent back-water laps. Ensure all roofing and flashing substrates are prepared and acceptable to receive the heat-welded membrane. Cut membrane to working lengths and widths to conform to rooftop conditions, and lay out to always work to a selvage edge. Ensure specified side-laps and end-laps are maintained. End-laps should be staggered 3 ft apart. Direct roof torch on the roll as necessary to prevent overheating and damaging the membrane and substrates. As the membrane is unrolled, apply heat to the underside of the membrane until the plastic burn-off film melts away. Continuously move the torch side-to-side across the underside of the roll to melt the bitumen on the underside of the sheet, while continuously unrolling membrane. While unrolling and heating the sheet, ensure approximately $\frac{1}{4}$ to $\frac{1}{2}$ in of hot bitumen flows ahead of the roll as it is unrolled, and there is $\frac{1}{8}$ to $\frac{1}{4}$ in bleed out at all laps. Adjust the application of heat to the underside of the membrane and to substrate as required for varying substrates and environmental conditions. At the 6 in end-laps, melt the plastic burn-off film from the top surface or embed granules and remove surfacing, where present, using a torch or hot-air welder. At end-laps where T-Joints exist, cut a 45 degree dog-ear away from the selvage edge, or otherwise ensure the membrane is fully heat-welded watertight at all T-joints. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight. Where necessary, use a torch or hot-air welder and a clean trowel to ensure all laps are fully sealed. Inspect the installation each day to ensure the plies are fully adhered. Repair all voids, wrinkles, open laps and all other deficiencies. Offset cap sheet side and end-laps away from the base ply laps so that cap sheet laps are not located within 18 in of base ply laps.

- H. **HEAT WELDED, FULLY ADHERED FLASHING APPLICATION:** Refer to SBS manufacturer's membrane application instructions, flashing detail drawings, and follow product data sheets and other published requirements for installation instructions. Refer to manufacturer's membrane flashing detail drawings. The contractor is responsible for project safety. Refer to NRCA CERTA recommendations and building owner requirements for hot work operations. Where required to seal substrates for fire safety, install specified adhered, self-adhered or fastened backer ply to the substrate. Ensure backer-ply covers and seals all substrates requiring protection from exposure to torch operations. Ensure all flashing substrates that require primer are primed, and the primer is fully dry. Unroll the flashing base ply and flashing cap sheet onto the roof surface to their complete length. Once relaxed, cut the membrane to the required working lengths to accommodate the flashing height, cants and the required over-lap onto the horizontal roof surface. Cut the flashing membrane from the end of the roll in order to always install flashings to the side-lap line or selvage edge line. Lay out the flashing base ply and flashing Cap Sheet to offset all side-laps a minimum of 12 inches so that side-laps are never aligned on top of the ply beneath. Shingle the flashing ply laps to prevent back-water laps. Install non-combustible cant strips at transitions where required. Ensure correct membrane and flashing sequencing to achieve redundant, multi-ply, watertight flashings.
1. Apply all layers of roofing perpendicular to the slope of the deck.
 2. Fully bond the base ply to the prepared substrate, utilizing minimum 3 inch side and end laps. Apply each sheet directly behind the cold adhesive applicator. Cut a dog ear angle at the end laps on overlapping selvage edges. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger end laps a minimum of 3 feet.
 3. Fully bond the finish ply to the base ply, utilizing minimum 3 inch side and end laps. Apply each sheet directly behind the cold adhesive applicator. Stagger end laps of the finish ply a minimum 3 feet. Cut a dog ear angle at the end laps on overlapping selvage edges. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger side laps of the finish ply a minimum 12 inches from side laps in the underlying base ply. Stagger end laps of the finish ply a minimum 3 feet from end laps in the underlying base ply.
- I. **GRANULE EMBEDMENT:** Broadcast mineral granules over all adhesive over-runs on the finished ply surface, to ensure a monolithic surface color.
- J. **WATER CUT-OFF:** At end of day's work, or when precipitation is imminent, construct a water cut-off at all open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to the resumption of roofing.
- K. Flashing shall be accomplished using a reinforcing ply and flashing ply. The reinforcing sheet shall be lapped a minimum of (3) inches to itself and shall extend a minimum of four (4) inches onto the base ply surface and a minimum of three (3) inches up the vertical termination. The flashing sheet shall be lapped a minimum of three (3) inches to itself and shall extend a minimum of six (6) inches onto the surface ply surface and a minimum of eight (8) inches up the vertical termination or as noted in the detail Drawings. Lap seams in the reinforcing layer shall never coincide with the laps of the flashing layer. The reinforcing sheet shall be adhered by cold adhesive (in accordance with the manufacturer's guidelines) and mechanically attached to the wall at the leading edge. The flashing sheet shall be adhered by cold adhesive (in accordance with the manufacturer's guidelines) and be mechanically attached to the wall at the leading edge. All flashing sheets shall be cut off the end of the roll

and be applied vertically, always working to a selvage edge. Where indicated on drawings, attach vertical flashing w/ stainless steel termination bars fastened at 12" o.c.

- L. The Roofing Contractor shall furnish and install drain plugs during the roofing operations to keep each drain plugged temporarily so that in no case will sealants, adhesives, insulation, membrane cuttings, or any other debris be allowed enter into the drain openings. These plugs shall be a commercial product, specially equipped with a device which affords easy visibility. Should accidental spillings occur, the Contractor, at his expense, shall immediately clear out the drain to the satisfaction of Project Manager. Do not leave plugs in overnight.
- M. The Roofing Contractor shall paint cast-iron roof drain strainers at each existing roof drain location. Verify quantity prior to Bid.
- N. Miscellaneous: The ponding of any water on the roof surface after installation of the roofing system is not acceptable and will be grounds for rejection of the roof. Ponding is herein defined as precipitation remaining in an area of 100 continuous square feet, or larger, 1/2-inch or deeper for a period of 24 hours from the termination of precipitation.

3.6 FIELD QUALITY CONTROL

- A. Correct deficiencies in or remove and replace roof membrane that inspections and test reports indicate does not comply with specified requirements.
 - 1. Repair roof membrane that does not comply with specified requirements by re-adhering test specimens back in place and by applying additional plies, equal to the original number of plies specified, over test specimens according to roofing system manufacturer's written instructions.
- B. Additional testing, at Contractor's expense, may be performed to determine that corrected Work complies with specified requirements.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect and Owner 48 hours in advance of the date and time of inspection.

3.7 PROTECTING AND CLEANING

- A. Protect multiple ply asphalt elastomer membrane roof 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 Architect and Owner.
- B. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair base flashings to a condition free of damage and deterioration at the time of Substantial Completion and according to warranty requirements.

END OF SECTION 07 51 00

SECTION 07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fully Adhered polyvinyl-chloride (PVC) feltback/fleeceback roofing system.
2. Roof insulation.

1.2 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Verification: For the following products:
1. Sheet roofing, of color required.
 2. Walkway pads or rolls, of color required.
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing system.
- E. Manufacturer Certificates: Signed by roofing manufacturer certifying that the roofing system complies with requirements specified in the "Performance Requirements" Article. Upon request, submit evidence of meeting requirements.
- F. Qualification Data: For firms and persons specified in the "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.

- G. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of components of roofing system with requirements based on comprehensive testing of current product compositions.
- H. Warranty: Sample copy of roofing system manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.5 INFORMATIONAL SUBMITTALS

- A. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- B. Sample Warranties: For manufacturer's special warranties. All items listed under the Article 1.8 "Warranty" shall also be addressed.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in the maintenance manuals specified in Division 01. Include the following:
 - 1. Roofing manufacturer's recommendations for preventive and routine maintenance.
 - 2. A schedule for periodic roof inspections and repair, including:
 - a. Inspection at least twice a year, preferably in the spring and fall.
 - b. Inspection after severe weather or storms and removal of all debris from roof.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing roofing similar to that required for this Project and who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product.
- B. Source Limitations: Obtain components including roof membrane, substrate board, cover board, roof insulation, metal edging, fastener assemblies, flashings, counter-flashings, adhesives, sealants and all other products required for a complete membrane roofing system from same manufacturer as membrane roofing or as approved by membrane roofing manufacturer.
- C. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

1.8 WARRANTY

- A. General Warranty: The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents, Uniform Commercial Code regulations or applicable state statutes of limitations. This warranty shall be

in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

- A. Special Total Roofing System Warranty: Submit a written warranty, without deductible and without monetary limitation, signed by roofing system manufacturer agreeing to promptly repair leaks in the roofing system resulting from defects in materials or workmanship within the specified warranty period.
1. The Contractor shall warrant the materials and workmanship of the roofing system against leakage and against defects to faulty materials, workmanship and contract negligence for a period of five (5) years following acceptance of the project by the Owner.
 2. Warranty Period: 20 years from date of Final Acceptance (no dollar limit).
 3. Warranty shall include the roof membrane, substrate board, cover board, roof insulation, metal edging, fastener assemblies, flashings, counter-flashings, adhesives, sealants, and all other components required for a complete membrane roofing system installation.
 4. Warranty shall include roofing system installer's agreement to perform emergency repairs within 24 hours notice of an observed leak and to perform permanent repairs within 30 days thereafter.
 5. Warranty shall cover all damages resulting from calculated maximum wind speeds based on ASCE 7 and requirements of building Code having jurisdiction over Project.
 6. This warranty shall be non-prorated and fully transferable to new building Owner within the original warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain components including roof insulation, fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
- B. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing agency to resist the uplift pressures calculated to ASCE 7.
- D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- E. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.3 PVC ROOFING

- A. PVC Sheet: ASTM 4434 (latest version, Type III, polyester-reinforced, felt backed/fleecebacked. Membrane thickness meeting or exceeding the specified thickness when tested according to ASTM D751. Membrane shall have monolithic top ply above scrim.
 - 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:
 - a. (BASIS OF DESIGN) VersiFleece PVC; Versico Roofing Systems
 - b. PVC SureFlex, Carlisle Syntec
 - c. Flex FB 60 PVC, Flex Membranes International
 - d. Duro-Fleece, Duro-Last Roofing Systems
 - 2. Total Sheet Membrane Thickness: Manufacturer's feltback/fleeceback thickness laminated to membrane to provide a total finished sheet thickness of 115 mils minimum.
 - 3. Thickness: 60 mils, nominal excluding fleeceback thickness

Exposed Face Color: White.

2.4 AUXILIARY ROOFING 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, polyester reinforcement, thickness, and color as PVC sheet membrane.
- C. Fleece Back Bonding Adhesive: Manufacturer's standard low-rise, VOC-free, construction grade, two-component polyurethane adhesive.
- D. Flashing Bonding Adhesive: Manufacturer's standard Low VOC bonding adhesive used to bond bare back membrane to substrates.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- F. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets and all other accessories recommended by roofing system manufacturer for intended use.

2.5 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces. Insulation shall comply with UL design #1256.
- B. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
- C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

- A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer.

2.7 COVER BOARD

- A. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
 - 1. DensDeck Prime roof board; Georgia-Pacific Gypsum
 - 2. Securock Glass-Mat roof board; USG
 - 3. or approved substitute.

2.8 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.1 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

- 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. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements of all applicable codes and the roofing system manufacturer's written instructions.
 - 2. Fasten insulation according to requirements of FM's "Approval Guide" for specified Windstorm Resistance Classification.

3.2 COVER BOARD

- A. Cover Board: Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and adhere to substrate in same manner as insulation.
 - 1. Fasten cover board according to requirements of all applicable codes and the roofing system manufacturer's written instructions.

3.3 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Install tapered insulation under area of roofing to conform to slopes indicated.
- C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
- D. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
 - 1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
 - 2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
 - 3. Install tapered insulation under area of roofing to conform to slopes indicated.
 - 4. Install insulation under area of roofing to achieve required thickness (minimum 5 inches). 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.
 - 5. Install insulation at minimum overall thickness of 5 inches
 - 6. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

- a. Fasten insulation according to requirements of all applicable codes and the roofing system manufacturer's written instructions.
7. Fasten insulation according to requirements of FM's "Approval Guide" for specified Windstorm Resistance Classification.

3.4 ADHERED ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
 1. Install sheet according to ASTM D 5036.
- B. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- D. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
- E. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.
 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- F. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.5 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.6 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Preliminary Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on initial completion. Provide copy of report for Owner and Architect review. This letter should address any items needing to be fixed in order for the warranty to be issued.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion. This letter should indicate that the warranty will be issued for the Project based on their inspection.
- C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

3.8 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall 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 manufacturer of affected construction.

END OF SECTION 075419

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed wall sheet metal fabrications.
5. Prefinished parapet copings

1.2 PREINSTALLATION MEETINGS

- ##### A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

- ##### B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Distinguish between shop- and field-assembled work.
3. Include identification of finish for each item.
4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

- ##### C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- ##### A. Product certificates.

- ##### B. Product test reports.

- ##### C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- ##### A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. General: Install flashing and trim to withstand windloads, thermally induced movement and exposure to weather without failing, rattling, leaking and fastener displacement.
 - 2. For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.
 - 3. Roof Edge systems shall be designed and tested in accordance with ANSI/SPRI ES-1.
 - 4. SPRI Single Ply Roofing Industry Standards.

1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Finish Warranty Period: 20 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- 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 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.
- C. SPRI Wind Design Standard: Manufacture and install copings, roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: As indicated on Drawings or if not indicated as required by local code.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

- B. Manufacturers for sheet metal fabrications:
 - 1. OMG Roofing Products (formerly WP Hickman)
 - 2. MM Systems
 - 3. Peterson Aluminum
 - 4. Metal-Era

- C. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
 - 1. As-Milled Finish: Standard one-side bright.
 - 2. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 3. Color: Match the adjacent wall materials in which the flashing is installed.

- D. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Exposed Coil-Coated Finish:
 - a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Color: Match the adjacent wall materials in which the flashing is installed.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

- c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
2. All nails, screws, bolts, rivets and other fastenings for sheet metal, unless otherwise noted shall be type 304 or 305 stainless steel, galvanized steel or cadmium steel, and of size and type suitable for intended use.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- G. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 MANUFACTURED REGLETS

- A. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cheney Flashing Company.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products, Inc.
 - d. Hickman, W. P. Company.
 - e. Hohmann & Barnard, Inc.
 - f. Keystone Flashing Company, Inc.
 - g. National Sheet Metal Systems, Inc.
 - h. Sandell Manufacturing.
 2. Material: Aluminum, 0.024 inch thick.
 3. Finish: With manufacturer's standard color coating.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry,

metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
 2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- C. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. With Architects approval, rivet joints where necessary for strength.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
1. Hanger Style: Submit options for Architect selection.
 2. Fabricate from the following materials:
 - a. Aluminum: 0.024 inch thick.
- B. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
1. Aluminum: 0.040 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch long, but not exceeding 12-foot long sections. Furnish with 6-inch wide, joint cover plates. Shop fabricate interior and exterior corners.
1. Fabricate from the Following Materials:
 - a. Aluminum: 0.050 inch thick.

- B. Prefinished Parapet Copings: Fabricate in minimum 96-inch long, but not exceeding 12-foot long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, fasten weld watertight. Interior and exterior corners shall be fabricated by the coping manufacturer. Field made corners are not acceptable. Fabricate from the Following Materials:
 - a. Aluminum: 0.050 inch thick.
- C. Base Flashing: Field made corners are not acceptable. Fabricate from the following materials:
 - 1. Aluminum: 0.040 inch.
- D. Counterflashing and Flashing Receivers: Fabricate from the following materials:
 - 1. Aluminum: 0.032 inch thick.
- E. Prefinished Parapet Coping Manufacturers:
 - 1. OMG Roofing Products (formerly WP Hickman Company)
 - 2. Petersen Architectural Corp.
 - 3. Carlisle Syntec
- F. Color: Match the adjacent wall panel materials upon which the fascia caps and parapet copings are installed.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 - 5. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
1. Do not solder metallic-coated steel and aluminum sheet.
- G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.2 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.
- C. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant compatible with the substrate.
- D. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints minimum of 4 inches in direction of water flow.

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.4 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Through-Wall Flashing: Installation of through-wall flashing is specified in Section 04 20 00 "Unit Masonry".
- C. Reglets: Installation of reglets is specified in Section 04 20 00 "Unit Masonry."

3.5 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean off excess sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 07 62 00

SECTION 07 72 33 - ROOF HATCH

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all of the labor, materials, equipment and services to furnish and install the roof hatch as shown.

1.2 SUBMITTALS:

- A. Prior to installation, submit to the Architect for review the following:
 - 1. Complete and fully descriptive manufacturer's literature.
 - 2. Shop drawings that shall include, but not be limited to: Materials, gauges, roof opening and door sizes, method of installation into the roof, hardware, accessories and door finish.

PART 2 - PRODUCTS

2.1 ROOF HATCH:

- A. Basis of Design Manufacturer: Bilco Roof Hatch Type S-50TB (Thermally Broken and Insulated Roof Hatch (aluminum), LadderUP Safety Post aluminum Model LU-4.
- B. Acceptable manufacturers: Babcock-Davis, Precision Ladders, LLC, or approved equal.
- C. Size: 36" x 30".
- D. Provide padlock with keys.
- E. Curb shall be 12" in height, 11 gauge aluminum. The curb insulation shall be rigid, high density fiberboard of 1" thickness on outside of curb.
- F. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
- G. Hardware
 - 1. Heavy pintle hinges shall be provided
 - 2. Cover shall be equipped with a spring latch with interior and exterior turn handles
 - 3. Roof hatch shall be equipped with interior and exterior padlock hasps.
 - 4. The latch strike shall be a stamped component bolted to the curb assembly.
- H. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space. Factory finish shall be mill finish aluminum.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Roof hatch shall be provided in strict accordance with the Contract Documents, the approved

submittals and the manufacturer's instructions.

- B. The complete installation shall be weathertight.

3.2 FABRICATION:

- A. Shop prefabricate the roof hatch verifying all measurements at the job site prior to fabrication.
- B. Fabricate in strict accordance with the approved submittals and the manufacturer's published recommendations.
- C. Weld or mechanically fasten along entire line of contact on the unexposed side.

3.3 INSTALLATION:

- A. Install all members with adequate provision for settling, expanding and contracting to occur without breaking the weather seal.
- B. Firmly anchor all members, using all anchoring devices required to ensure positive attachment of the members for long life under hard use.
- C. Protect all finished surfaces as necessary to prevent damage during progress of the Work.

3.4 CLEANING UP:

- A. Immediately prior to acceptance of the Work, remove all protective materials from the roof hatch system and clean all exposed members.
- B. Do not use abrasive or harmful cleaning agents.

END OF SECTION 07 72 33

SECTION 07 84 00 - THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration fire-stop systems for the following types of fire-resistance-rated assemblies:
 - 1. Floors.
 - 2. Roofs.
 - 3. Walls and partitions.
 - 4. Smoke barriers.
 - 5. Construction enclosing compartmentalized areas.

1.2 PERFORMANCE REQUIREMENTS

- A. F-Ratings: Provide firestop systems with F-ratings equaling or exceeding fire-resistance rating of constructions penetrated as determined per ASTM E 814/UL1479.
- B. T-Ratings: Provide firestop systems with T-ratings required, as well as F-ratings, determined per ASTM E 814/UL 1479, where systems protect penetrating items with potential to contact adjacent materials in occupiable floor areas including, but not limited, to the following:
 - 1. Penetrations located outside wall cavities.
 - 2. Penetrations located outside fire-resistive shaft enclosures.
 - 3. Penetrations located in construction containing fire-protection-rated openings.
 - 4. Penetrating items larger than 4-inch- diameter nominal pipe or 16 sq. in. in overall cross-sectional area.
- C. For firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread indices of less than 25 and smoke-developed indices of less than 450, when tested per ASTM E 84.
- E. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- F. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

- G. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests shall be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings shall follow requirements set forth by the International Firestop Council (September 7, 1994).

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Include details of installation and design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
- C. Product certificates and test reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide rated systems identical to those tested per ASTM E 814/UL 1479 and with products bearing the classification marking of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate firestop systems.

1.6 INSTALLER QUALIFICATIONS

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the Firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its Firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with through penetration firestop systems (XHEZ) and joint systems (XHBN) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
 - 1. Hilti Construction Chemicals, Inc.
 - 2. 3M Fire Protection Products.
 - 3. Tremco; Sealant/Weatherproofing Division.
 - 4. Grace, W. R. & Co. - Conn.
- B. One manufacturer shall be used for Firestopping on entire project. Manufacturer shall be present at pre-construction meeting and provide training to installers.

2.2 FIRESTOP SYSTEMS

- A. Compatibility: Provide firestop systems that are compatible with the substrates forming openings, and with the items, if any, penetrating firestop systems, under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Provide components for each firestop system that are needed to install fill material. Use only components specified by the firestop system manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Clean openings immediately before installing firestop systems.
 - 1. Remove foreign materials that could interfere with adhesion of firestop systems.
 - 2. Remove laitance and form-release agents from concrete.
 - 3. Produce clean, sound surfaces capable of developing optimum bond with firestop systems. Remove loose particles remaining from cleaning operation.
- C. Priming: Prime substrates when recommended in writing by firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not spill primers or allow them to migrate onto adjoining surfaces.
- D. Masking Tape: Use masking tape where required to prevent contact of firestopping with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove firestopping smears. Remove tape immediately after installation without disturbing firestopping seal.
- E. Accessories: Install accessories of types required to support fill materials during their application and in the position necessary to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories that are not permanent components of firestop systems.
- F. Install fill materials for firestop systems by proven techniques.
1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- G. Identification: Identify firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible. Include the following information on labels:
1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Firestop system manufacturer's name.
 6. Installer's name.
- H. Clean excess fill materials adjacent to openings as installation progresses by methods and with cleaning materials that are approved in writing by manufacturers and that do not damage materials in which openings occur.

3.2 FIELD QUALITY CONTROL

- A. Do not cover up firestop system installations that will become concealed behind other construction until inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.
- B. Inspecting agency will state in each report whether inspected firestop systems comply with or deviate from requirements.
- C. Enclose firestop systems with other construction only after inspection reports are issued.
- D. Where deficiencies are found, repair or replace firestop systems to comply with requirements.

END OF SECTION 07 84 00

SECTION 07 90 00 - SEALANTS

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all of the labor, materials, equipment, and services required to furnish and install the sealant and caulking.
- B. The purpose of caulking in this Work is to provide a positive barrier against penetration of air and moisture at joints between items where caulking is essential to continued integrity of the barrier.

1.2 SUBMITTALS:

- A. Prior to installation, submit the following to the Architect for review:
 - 1. Complete and fully descriptive manufacturer's literature for each type of sealant used naming product formulation and giving product limitations.
 - 2. Data proving the product meets or exceeds the ASTM number referenced.
 - 3. Color chart for the Architect's selection.
 - 4. Submit statements by the manufacturers and installers of their acceptance of these documents and conditions and/or any modification proposed to the use of the products. Include a statement from the manufacturer that the proposed use of the product for the conditions encountered is proper.
 - 5. Submit a guarantee warranting all defects of material and/or application for a period of five (5) years from Date of Substantial Completion. Any failure that may occur within this warranty period, due to defective application and/or materials shall, upon written notification of such failure, be repaired or replaced with proper materials and/or labor as approved by the Architect, at no additional cost to the Owner.

1.3 DEFINITIONS:

- A. The terms "Sealant" and "Caulking" shall be used interchangeably throughout the Contract Documents and shall be interpreted to mean the same material.

PART 2 - PRODUCTS

2.1 SEALANT - EXPANSION JOINTS, CONTROL JOINTS, AND PERIMETER OF DOOR AND WINDOW FRAMES:

- A. Neutral Curing Silicone Sealant, conforming to ASTM C 920, Type S, Grade NS, Class 100 sealant. For use in all exterior building joints.
 - 1. Pecora 890/890 FTS (Field Tintable Silicone).
 - 2. Tremco Spectrum 1 or 2.
 - 3. Dow 790/756 Building Sealant.
 - 4. Or an approved substitute.
- B. Joint Backing: Backer rod as recommended by sealant manufacturer.

- C. Where joint depth does not permit use of joint backing, a release paper or bond breaker shall be used.
- D. On horizontal joints, surface must be cleaned and primed using primer as recommended by the sealant manufacturer.

2.2 SEALANT - SETTING THRESHOLD; FLASHING; AND GENERAL SEALING NOT OTHERWISE DELEGATED:

- A. Pecora Corp. Dynatrol I,
- B. Tremco Spectrum 1 or 2,
- C. Dow General Purpose Silicone Sealant,
Or an approved substitute.
- D. Joint Backing: Round closed-cell polyethylene.

2.3 PRIMERS:

- A. As recommended by the sealant manufacturer for use in conjunction with the sealant for application onto the various types of materials to which the sealant is applied, and complying with the requirements above. When the manufacturer's instructions make reference to use of primers and/or the construction condition requires special surface preparation, these instructions shall be complied with.

2.4 CLEANERS:

- A. Where required by manufacturer's instruction in lieu of primers, shall be of the type and kind recommended by the sealant manufacturer.

PART 3 - EXECUTION

3.1 CHOICE OF CAULKING MATERIAL:

- A. Use only that caulking material which is best suited to the installation and is so recommended by the caulking material manufacturer.

3.2 BACK-UP MATERIALS:

- A. Verify the compatibility of filler materials with caulking before installation.
- B. Use filler about 1/3 to 1/2 wider than width of joint so sufficient pressure is exerted by filler to provide substantial resistance to displacement.
- C. All filler materials shall be non-oily, non-staining, back-up filler such as polyethylene foam rod, expanded polyurethane, neoprene or other filler completely compatible with the caulking material.

3.3 APPLICATION OF CAULKING:

- A. Do not caulk under weather conditions or sun conditions potentially harmful to the set and curing of the caulking material.
- B. Deliver materials to the job or place of application in original unopened containers bearing manufacturer's name and product designation.
- C. Install caulking in strict accordance with the manufacturer's recommendations, taking care to produce beads of proper width and depth, to tool as recommended by the manufacturer, and to immediately remove all surplus caulking.

3.4 CAULKING SCHEDULE:

- A. Carefully study the Drawings and furnish and install the proper caulking at each point where called for on the Drawings plus at all other points, whether specifically designated or not, where caulking is essential in maintaining the continued integrity of the intended watertight barrier.

END OF SECTION 07 90 00

Division 08 - Openings

SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

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. Steel doors.
 - 2. Steel door frames.
 - 3. Sidelight frames
 - 4. Fire-rated door and frame assemblies.
 - 5. Louvers in doors.
- B. Related Sections include the following:
 - 1. Division 04 Section "Unit Masonry" for installing anchors and grouting frames in masonry construction.
 - 2. Division 08 Section "Flush Wood Doors" for wood doors installed in steel frames.
 - 3. Division 08 Section "Door Hardware"
 - 4. Division 08 Section "Glass Glazing" for glass in glazed openings in doors and frames.
 - 5. Division 09 Section "Gypsum Board Assemblies" for spot-grouting frames installed in steel-framed gypsum board partitions.
 - 6. Division 09 Section "Painting" for field painting factory-primed doors and frames.

1.3 DEFINITIONS

- A. Steel Sheet Thicknesses or gages: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

1.4 SUBMITTALS

- A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings.
- B. Shop Drawings: Show the following:
 - 1. Elevations of each door design.
 - 2. Details of doors including vertical and horizontal edge details.
 - 3. Frame details for each frame type including dimensioned profiles.
 - 4. Details and locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, accessories, joints, and connections.
 - 7. Coordination of glazing frames and stops with glass and glazing requirements.
- C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.5 QUALITY ASSURANCE

- A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252. After 5 minutes into the NFPA 252 test the neutral pressure plane shall be established in the furnace at 40" or less above the floor.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inch-high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Doors and Frames:
 - a. Ceco Door Products; an ASSA ABLOY Group Company.
 - b. CURRIES Company; an ASSA ABLOY Group Company.
 - c. Steelcraft; an Ingersoll-Rand Company.
 - d. Fleming Door Products Ltd.; an ASSA ABLOY Group Company.

2.2 MATERIALS

- A. Hot-Rolled Steel Sheets: ASTM A 569, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- B. Cold-Rolled Steel Sheets: ASTM A 366, Commercial Steel (CS), or ASTM A 620, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.
- C. Metallic-Coated Steel Sheets: ASTM A 653, Commercial Steel (CS), Type B, with an A40 zinc-iron-alloy (galvannealed) coating; stretcher-leveled standard of flatness.
- D. Recycled Steel Content: Provide products with an average recycled content of steel products so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

2.3 DOORS

- A. General: Provide doors of sizes, thicknesses, gages, and designs indicated. Fabricate all doors and frames in accordance with ANSI A250.8-1998/S.D.I.-100 except where more stringent requirements are specified. Bevel lock edges 1/8 inch in 2 inches.
1. Interior Doors: Classification; 1-3/4" thick, Level 2 – Model 1, 18 gauge cold rolled, full flush of composite construction. The top and bottom of the doors shall be closed by 16 gage inverted steel channels. Top channel shall receive flush metal top cap.
 2. Exterior Doors: Classification; 1-3/4" thick, Level 32 – Model 21, 16 gauge A-60 galvanized, seamless edge construction. The top and bottom of the doors shall be closed by 16 gage inverted steel channels. Top channel shall receive flush metal top cap.
- B. Door Louvers: Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch-thick steel frame.
- C. Vision Lite Systems: Manufacturer's standard kits consisting of glass lite moldings to accommodate glass thickness and size of vision lite indicated.

2.4 FRAMES

- A. General: Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.
- B. Frames of 16 gage A60 metallic-coated steel sheet for:
1. Exterior steel doors.
- C. Frames of 16 gage cold rolled steel sheet for:
1. Interior Steel and Wood doors.
- D. Hinge reinforcements shall be 7-gage steel for hinge sizes shown. Where heavyweight hinges are scheduled, weld high-frequency hinge straps to the top and bottom of each reinforcement and frame.
- E. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.
- F. Where indicated furnish Kerfed type jamb profile to accept manufacturer's appropriate gasket for smoke seals, sound seals or weather-stripping.
- G. Plaster Guards: Provide 0.016-inch- thick, steel sheet plaster guards or mortar boxes to close off interior of openings; place at back of hardware cutouts where mortar or other materials might obstruct hardware operation.
- H. Supports and Anchors: Fabricated from not less than 0.042-inch- thick, electrolytic zinc-coated or metallic-coated steel sheet.
1. Wall Anchors in Masonry Construction: 0.177-inch- diameter, steel wire complying with ASTM A 510 may be used in place of steel sheet.
- I. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153, Class C or D as applicable.

2.5 FABRICATION

- A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
- B. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.
- C. Clearances for Fire-Rated Doors: As required by NFPA 80 and UL10-C.
- D. Single-Acting, Door-Edge Profile: Square edge, unless beveled edge is indicated.
- E. Double-Acting, Door-Edge Profile: Round vertical edges with 2-1/8-inch radius.
- F. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- G. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.
- H. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- I. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies. Minimum insulation value of R-10.
- J. Sound-Rated (Acoustical) Assemblies: Where shown or scheduled, provide door and frame assemblies fabricated as sound-reducing type, tested according to ASTM E 1408, and classified according to ASTM E 413.
- K. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
- L. Frame Construction: Fabricate frames to shape shown.
 - 1. Fabricate frames with mitered or coped and continuously welded corners
- M. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
- N. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.
- O. Glazing Stops: Manufacturer's standard, formed from 0.032-inch-thick steel sheet.
 - 1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
 - 2. Provide screw-applied, removable, glazing stops on inside of glass, louvers, and other panels in doors.
- P. Astragals: Furnish at pairs as required by NFPA 80 to provide fire ratings indicated.

2.6 FINISHES

- A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - 1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
 - 2. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
 - 3. In existing concrete or masonry construction, provide at least three completed opening anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
 - 4. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
 - 5. Install fire-rated frames according to NFPA 80.
 - 6. For openings 90 inches or more in height, install an additional anchor at hinge and strike jambs.
- C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
 - 1. Fire-Rated Doors: Install within clearances specified in NFPA 80.
 - 2. Smoke-Control Doors: Install to comply with NFPA 105.

3.2 ADJUSTING AND CLEANING

- A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.
- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 08 11 13

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all labor, materials, equipment and services to furnish and install the flush wood doors.

1.2 QUALITY ASSURANCE:

- A. Comply with the applicable requirements of the following standards unless otherwise indicated.
 1. ANSI/WDMA I.S. 1-78, "Industry Standard for Wood Flush Doors".
 2. UL10-C fire test for mineral core fire doors.
 3. Provide doors with fire-resistance ratings indicated or required to comply with governing regulations.
 4. All labeled doors shall be manufactured in accordance with the specifications procedures of the Underwriter's Laboratories. All labeled doors shall physically bear the U.L. label showing the rating required.

1.3 SUBMITTALS:

- A. Prior to fabrication, submit the following to the Architect for review:
 1. Complete and fully descriptive manufacturer's literature.
 2. Shop drawings: Sizes, face veneer, edge construction, core construction, necessary details, and factory finishing.
 3. Door schedule: Show door sizes, opening numbers or designations and elevations, door type, fire classification marking, swing, light and louver cutout sizes and locations, and undercut.
 4. Physical sample: Cross section at door corner.
 5. Certification: Submit written certification signed by an officer of the manufacturing firm that shall certify that the materials delivered to this work comply in all respects with the requirements of the Contract Documents.

1.4 GUARANTEE:

- A. Submit written guarantee for use for the life of the installation, including repair and/or replacement, and refinishing of defective material in accordance with the standard door guarantee of the National Woodwork Manufacturer's Association.

1.5 PRODUCT HANDLING:

- A. Package each door at the factory in separate heavy paper-type carton or poly bag. Mark each carton or door for location to correspond with opening number on Drawings.

PART 2 – PRODUCTS

2.1 INTERIOR DOORS - SOLID CORE - FOR STAIN FINISH:

- A. WDMA Premium Grade 5-Ply Hot Press Construction

- B. Species and Cut:
1. Quarter sliced White Birch, Book match and balance match. Factory finish where clear or stained finish is called for.
- C. Core construction:
1. Non-rated: Agrifiber Particle Core Board
 2. Rated: Mineral - 45 minute or greater. Furnish Category "A" imbedded intumescent insert.
 3. Provide 5" inner blocking at top rail of mineral core doors.
 4. Provide inner blocking for locks and panics at mineral core doors.
 5. Provide bonded core assembly.
- D. Subject to compliance of all specifications in this section.
Acceptable manufacturers are:
1. Marshfield Door systems, Inc.
 2. Algoma Hardwoods Inc.
 3. Eggers Industries; Architectural Door Division.
 4. Oshkosh Architectural Door Company.
 5. Graham Manufacturing.
- E. Factory Finish: Manufacturer's standard finish with performance comparable to AWI System TR-6 catalyzed polyurethane.
- Staining: Must match "Basis of Design Color" as listed on sheet A700 as Honey finish on Finish Legend. Designer/Owner approval required. This is a critical aesthetic match.

2.2 LIGHTS AND LOUVERS:

- A. Provide openings with stops for lights and louvers.
- B. Provide the manufacturer's standard wood louvers if indicated.

2.3 PRE-FITTING AND PRE-MACHINING:

- A. Pre-fit doors at the factory in accordance with tolerance requirements of the WDMA standards with allowances for undercuts (if any). Provide standard bevel or radius to edge of door as required for the installation.
- B. Machine doors for butts, locksets, concealed closers, concealed holders, concealed exit hardware and flush bolts. Machine in accordance with templates of approved hardware manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine door frames and verify that frames are correct type and have been installed as required for proper hanging of corresponding doors. Correct any conditions that will be detrimental to proper and timely installation of wood doors. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. Condition doors to average prevailing humidity in installation area prior to hanging.
- B. Hardware: See Section 08 71 00, "Door Hardware".
- C. Install wood doors in accordance with manufacturer's instructions and as shown.
- D. Pre-fit doors: Fit to frames and machine for hardware to whatever extent not previously worked at factory as required for proper fit and uniform clearance at each edge.
- E. Clearance:
 - 1. Non-rated doors: Provide clearances of 1/8" at jambs and heads; 1/8" at meeting stiles for pairs of doors; and 1/2" from bottom of door to top of finish floor material or covering. At thresholds, provide 1/4" clearance from bottom of door to top of threshold.
 - 2. Fire-rated doors: Provide clearances complying with NFPA.

3.3 ADJUST AND CLEAN:

- A. Re-hang or replace doors which do not swing or operate freely.
- B. Refinish or replace doors damaged during installation.

END OF SECTION 08 14 16

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes access doors and frames for walls and ceilings.

1.2 SUBMITTALS

- A. Product Data: For each type of access door and frame indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.3 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work.

1.4 QUALITY ASSURANCE:

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing products specified with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 STEEL MATERIALS

- A. Steel Sheet: electrolytic zinc-coated, ASTM A 591 with cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.
- B. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Factory-Primed Finish: Manufacturer's standard shop primer.
- C. Drywall Beads: 0.0299-inch zinc-coated steel sheet to receive joint compound.

- D. Plaster Beads: 0.0299-inch zinc-coated steel sheet with flange of expanded metal lath.
- E. Manufacturer's standard finish.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - B.
 - 1. Babcock-Davis; A Cierra Products Co.
 - 2. Bar-Co, Inc. Div.; Alfab, Inc.
 - 3. Cendrex Inc.
 - 4. Dur-Red Products.
 - 5. Elmdor/Stoneman; Div. of Acorn Engineering Co.
 - 6. FF Systems, Inc.
 - 7. Jensen Industries.
 - 8. J. L. Industries, Inc.
 - 9. Karp Associates, Inc.
 - 10. Larsen's Manufacturing Company.
 - 11. MIFAB, Inc.
 - 12. Milcor Inc.
 - 13. Nystrom, Inc.
 - 14. Williams Bros. Corporation of America (The).
- C. Flush Access Doors and Trimless Frames: Fabricated from metallic-coated steel sheet.
 - 1. Locations: Wall and ceiling surfaces as required.
 - 2. Door: Minimum 0.060-inch thick sheet metal.
 - 3. Frame: Minimum 0.060-inch thick sheet metal with drywall bead flange.
 - 4. Hinges: Spring-loaded, concealed-pin type.
 - 5. Latch: Cam latch with interior release.
 - 6. Lock: Cylinder.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view, provide materials with smooth, flat surfaces without blemishes.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.

- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder lock, furnish two keys per lock and key all locks alike. Coordinate cylinder and keying with Div 08 71 00 Door Hardware.
 - 2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

PART 3 - EXECUTION

3.1 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.

3.2 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 36 15 - SECTIONAL ALUMINUM AND GLASS OVERHEAD DOOR

PART 1 - GENERAL

1.01 SCOPE:

- A. Provide all of the labor, materials, equipment, and services required to furnish and install the overhead doors.

1.02 SUMMARY

- A. The work of this section includes upward-acting sectional doors.
- B. Related sections: Other specification sections which directly relate to the work of this section include, but are not limited to, the following:
 - 1. Section 05 50 00 Metal Fabrications (metal framing and supports)
 - 2. Section 08 71 00 Door Hardware (key cylinders for locks and switches)
 - 3. Division 26 Electrical (wiring)

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each type of sectional door. Include both published data and any specific data prepared for this project.
- B. Shop Drawings: Submit shop drawings for approval prior to fabrication. Include detailed plans, elevations, details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent materials.

1.04 QUALITY ASSURANCE

- A. Manufacturer: Sectional doors shall be manufactured by a firm with a minimum of five years experience in the fabrication and installation of sectional doors. Manufacturers proposed for use shall submit evidence of ability to meet performance and fabrication requirements specified, and include a list of five projects of similar design and complexity completed within the past five years.
- B. Installer: Installation of sectional doors shall be performed by the authorized representative of the manufacturer.
- C. Single-Source Responsibility: Provide doors, tracks, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.
- D. Pre-Installation Conference: Schedule and convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and products in labeled protective packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

PART 2 - PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS: (alternate products must be submitted 10 days prior to bid to be evaluated)
- A. Overhead Door Company 521 Series Aluminum and Glass Doors
 - B. Raynor Garage Doors AlumaView AV300 Aluminum Glass Doors
 - C. Wayne-Dalton AFV 452 Series Aluminum and Glass Doors
 - D. Clopay Commercial Aluminum and Glass door Model 903
 - E. Amarr Garage Doors Model 3552 HD Commercial Aluminum Full-View Doors
 - F. Arm-R-Lite Door Manufacturing Co. Model Aluminarc Welded Aluminum and Insulated Glass Doors
- 2.02 ALUMINUM SECTIONAL DOORS:
- A. Sectional Door Assembly: Stile and rail assembly secured with ¼" diameter through rods. Units shall have the following characteristics:
 - 1. Panel Thickness: 1 3/8" Min.
 - 2. Aluminum Panels: 0.050" thick, alloy 6063-T6
 - 3. Heavy Duty Springs: 100,000 cycles.
 - 4. Glazing: ½" insulated thermal pane, tempered and low-e
 - B. Finish and Color:
 - 1. Powder Coating Finish: See drawings for color information or if not indicated on drawings then as selected from Architect from manufacturers full range of color choices. Finish to have minimum 5 year warranty.
 - C. Windload Design: ANSI/DASMA 102 standards and as required by code.
 - D. Hardware: Provide heavy duty galvanized steel hinges and fixtures. Ball bearing rollers with hardened steel races.
 - E. Lock: Interior galvanized single unit.
 - F. Weatherstripping: Powder coated aluminum weather seals to match doors.
 - G. Track: Provide heavy duty track as recommended by manufacturer to suit loading required and clearances available (minimum 3" track).
 - H. Electric Motor Operation: Provide UL listed electric operator, equal to Liftmaster Elite Series UL 325-2010 compliant with Logic 4.0 technology. Provide minimum ¾ hp or larger if recommended by manufacturer. Provide jack-shaft style operation on wall. Provide minimum 240V 1P power to operator.
 - 1. Entrapment Protection: Provide 4 wire self monitoring wireless electric sensing edge up to 18' wide and photoelectric sensors. Wireless device should be equal to MEL Monitored Edge Link #MEL-K20 or Miller Edge, Inc. #MWCK02.
 - 2. Operator Controls: Push button operated control stations with open, close, and stop buttons for flush recessed mounting for interior locations. (note 2 required-1 at door and one at watch room or by doors into the apparatus room).

3. Special Operation: Pull-rope release automatic opening device, vehicle detector operation, radio control operation, and door timer operation. Coordinate the exact interface off all controls with Owner, electrician, and mason.
4. Provide 2 remote radio controllers (suitable for use in Fire Trucks) per door.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.
- B. Instruct Owner's personnel in proper operating procedures and maintenance schedule.

3.03 ADJUSTING AND CLEANING

- A. Test sectional doors for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Touch-up damaged coatings and repair minor damage. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer of material or product being cleaned.

END OF SECTION 08 36 15

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Exterior and interior aluminum-framed storefronts.
 - a. Glazing is retained mechanically with gaskets on four sides.
 - 2. Exterior and interior manual-swing aluminum doors.
 - 3. Exterior and interior aluminum door frames.

1.2 RELATED WORK

- 1. Section 08 81 00-Glass Glazing

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
 - 5. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Noise or vibration created by wind and thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Sealant failure.
 - g. Failure of operating units to function properly.
- B. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings or if not as required by local code.
 - 2. Seismic Loads: As indicated on Drawings or if not as required by local code.
- C. Deflection of Framing Members Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
- D. Structural-Test Performance: 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 less than 10 seconds.
- E. Temperature Change (Range): Systems accommodate 120 deg F, ambient; 180 deg F, material surfaces.

- F. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of systems 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 lbf/sq. ft.
- G. Water Penetration Under Static Pressure: Systems 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 10.0 lbf/sq. ft.
- H. Condensation Resistance: Fixed glazing and framing areas of systems have condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.
- I. Average Thermal Conductance: Fixed glazing and framing areas of systems have average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include structural analysis data with an engineer currently licensed in the state of North Carolina.
 - 2. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Samples: For each exposed finish.
- D. Product test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Acceptable to manufacturer and capable of preparation of data for aluminum-framed systems including Shop Drawings based on testing and engineering analysis currently licensed in the state of North Carolina. of manufacturer's standard units in assemblies similar to those indicated for this Project.

1.6 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water leakage through fixed glazing and framing areas.
 - e. Failure of operating components to function properly.
 - 2. Warranty Period: Two years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for aluminum-framed systems is based on EFCO Xtherm 403X. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. EFCO Corporation.
 2. Kawneer.
 3. YKK AP America Inc.

2.2 MATERIALS

- A. Aluminum: Extruded aluminum shall be 6063-T6 alloy and temper.
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.
- B. Steel Reinforcement if required to meet wind load requirements: With manufacturer's standard corrosion-resistant primer.
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.

2.3 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Framing members are composite assemblies of two separate extruded-aluminum components permanently bonded by an elastomeric material of low thermal conductance.
- 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 **FULLY CONCEALED** corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 2. Reinforce members as required to receive fastener threads.
- D. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.
- E. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.
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).
- F. Sunshades: Basis of Design: EFCO XTherm E-Shadow. Manufacturer's standard high-strength 6063-T6 aluminum with nonstaining, nonferrous shims for aligning system components. Arm and blade dimensions as indicated on drawings. Screw spline construction. Finish to match adjacent aluminum framing system.

2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glass Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types, replaceable, molded or extruded, that maintain uniform pressure and watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.

2.5 DOORS

- A. Doors: Manufacturer's standard glazed doors, for manual swing operation. Basis of Design: EFCO Series D502 Wide Stile Thermastile
 1. Doors shall be thermally broken.
 2. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.
 3. Door Design: As indicated. Exterior doors to have insulated tempered glass to match storefront glazing unless otherwise noted. Interior doors to have 1/4" clear tempered glazing unless otherwise noted.
 - a. Accessible Doors: Smooth surface for width of door in area within 10 inches above floor or ground plane.
- B. Fabrication
 1. All aluminum horizontal extrusions (blades) shall have a minimum wall thickness of .063" (1.5 mm) to .125" (3 mm).
 2. Sunshade "arms" and mullion clips shall be extrusions with a nominal wall thickness of .25" (6 mm).
 3. Sunshade Device - Horizontal components (blades) shall be mechanically fastened by means of extruded aluminum screw splines.

2.6 DOOR HARDWARE

- A. General: Provide heavy-duty units in sizes and types recommended by entrance system and hardware manufacturers for entrances and uses indicated.
- B. Scheduled Door Hardware: Provide door hardware according to the Door Hardware Schedule at the end of Part 3.
 1. Named Manufacturer's Products: Product designation and hardware manufacturer are listed in the Door Hardware Schedule at the end of Part 3 to establish minimum requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware.
 - a. Named products are basis-of-design products. Provide named hardware manufacturer's products or comparable products that are equivalent in function and quality and that are recommended and supplied by entrance system manufacturer.
- C. Cylinders: As specified in Division 08 Section "Door Hardware."
- D. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

- E. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
 - 2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- F. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

2.7 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Sealants."
- B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.8 FABRICATION

- A. Frame
 - 1. Depth of frame shall not be less than 4 1/2" (114 mm)
 - 2. Face dimension shall not be less than 2" (50 mm).
 - 3. Frame components shall be screw spline construction
- B. 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. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Mechanically Glazed Framing Members: Fabricate for flush glazing (without projecting stops).
- D. Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.
 - 1. At exterior and interior doors, provide compression weather stripping at fixed stops.
 - 2. Depth of frame shall not be less than 4 1/2" (114 mm)
 - 3. Face dimension shall not be less than 2" (50 mm)
 - 4. Shear block construction shall be utilized throughout
 - 5. System design shall be such that raw edges will not be visible at joints.
 - 6. Doors are capable of having separate interior and exterior finishes and/or colors.
- E. Doors: Reinforce doors as required for installing hardware.
 - 1. Major portions of the door sections shall have .125" (3 mm) wall thickness.
 - 2. Exterior glazing stops shall be an integral part of the door; glazing stop sections shall have .050" (1.2 mm) wall thickness. Interior stops shall be snap-in type.
 - 3. Mechanical fasteners, welded components and hardware items shall not bridge thermal barriers. Thermal barriers shall align at all corners

4. Depth of door frame shall not be less than 2" (50 mm).
 5. Stiles shall be no less than 3 1/2" (88 mm) in width
 6. At pairs of exterior doors, provide sliding wool pile weather stripping retained in adjustable strip mortised into door edge.
 7. At exterior doors, provide weather sweeps applied to door bottoms.
- F. Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.
- G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- 2.9 Thermal Barrier
- A. All exterior aluminum shall be separated from interior aluminum by a rigid, structural thermal barrier. For purposes of this specification, a structural thermal barrier is defined as a system that shall transfer shear during bending and, therefore, promote composite action between the exterior and interior extrusions.
 - B. The thermal barrier shall be thermal struts, consisting of glass reinforced polyamide nylon, mechanically crimped in raceways extruded in the exterior and interior extrusions.
 - C. Poured and debridged urethane thermal barriers shall not be permitted.
- 2.10 ALUMINUM FINISHES
- A. High-Performance Organic Finish: Two-coat thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Fit joints to produce hairline joints free of burrs and distortion.
 2. Rigidly secure nonmovement joints.
 3. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
 4. 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 by applying sealant or tape or 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 continuous sealant per manufacturer's recommendations and as specified in Division 07 Section "Sealants" and to produce weathertight installation.
- E. Install components plumb and true in alignment with established lines and grades, without warp or rack.
- F. Entrances: Install to produce smooth operation and tight fit at contact points.
 - 1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.
 - 2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- G. Install perimeter joint sealants as specified in Division 07 Section "Sealants" and to produce weathertight installation.
- H. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum 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.
 - 3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

END OF SECTION 08 41 13

SECTION 08 44 13 – GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes glazed aluminum curtain walls complete with related components.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples: For each exposed finish required.
- D. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Field quality-control reports.
- C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 WARRANTY

- A. Special Assembly Warranty: Installer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Minimum five years from date of Final Acceptance.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 20 years for Organic Paint Finish from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.

- d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
- 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
- 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches 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 1/360 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.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.
- E. Structural: Test according to ASTM E 330 as follows:
- 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
- 1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft.
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
- 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
- H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
- 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. EFCO Corporation; Series 5600 Xtherm-Outside Glazed with Duracast Fiberglass Pressure Plate – Basis of Design.
 2. Kawneer North America with fiberglass pressure plate.
 3. YKK AP America Inc. with fiberglass pressure plate.

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
 4. Finish: High-Performance Organic finish .
 5. Fabrication Method: Either factory- or field-fabricated system.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
1. Aluminum: Extruded aluminum shall be 6063-T6 alloy and temper.
 - a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 2. 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.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
 3. Glass
 - a. Ship open for monolithic glass by others
 4. Anchors

- a. Perimeter and floor line anchors shall be aluminum or steel. All steel anchors shall be properly insulated from the aluminum.
5. Duracast Pressure Plate
 - a. Material shall be a fiberglass composite with a Flexural strength of no less than 82 ksi(565 Mpa) along the lineal's major axis.
 - b. Material thermal conductivity shall be no more than 2 BTU·in/hr·ft²·°F (0.289 W/m²·K)
6. Sunshade Clips for Signage
 - a. Sunshade clips shall be extrusions with a nominal wall thickness of .25" (6 mm).
 - b. Extruded aluminum shall be 6063-T6 alloy and temper
 - c. Shear of clips shall meet imposed loads of signage by others
 - d. Connection of signage to clips shall be designed by signage manufacturer
 - e. Coordinate with Owner for exact location of clips for exterior signage

E. FABRICATION

1. Form or extrude aluminum shapes before finishing.
2. 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.
3. Fabricate components that, when assembled, have the following characteristics:
 - a. Profiles that are sharp, straight, and free of defects or deformations.
 - b. Accurately fitted joints with ends coped or mitered.
 - c. Physical and thermal isolation of glazing from framing members.
 - d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
4. Provisions for field replacement of glazing from exterior.
5. Fasteners, anchors, and connection devices that are **FULLY CONCEALED** from view.
6. Components curved to indicated radii.
7. Fabricate components to resist water penetration as follows:
 - a. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
8. Factory-Assembled Frame Units:
 - a. Rigidly secure non-movement joints.
 - b. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
 - c. Preparation includes, but is not limited to, cleaning and priming surfaces.
 - d. Seal joints watertight unless otherwise indicated.
 - e. Outside glazed curtain wall system shall be dry glazed with an exterior Duracast® pressure plate and snap cover with interior and exterior dense EPDM preset gaskets.
9. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.4 GLAZING

- A. Glazing: Comply with Section 08 81 00 "Glass Glazing."

- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
- D. Sealants used inside the weatherproofing system shall have a VOC content equal to or less than that allowed by the most current version of LEED.

2.5 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 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 non-movement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 7. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum is in 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 glazed aluminum curtain wall to exterior.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Section 08 81 00 "Glass Glazing."

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections.
- B. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

END OF SECTION 084413

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical door hardware

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section “Alternates” for alternates affecting this section.
2. Division 06 Section “Rough Carpentry”
3. Division 06 Section “Finish Carpentry”
4. Division 07 Section “Joint Sealants” for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
 - a. “Metal Doors and Frames”
 - b. “Flush Wood Doors”
 - c. “Interior Aluminum Doors and Frames”
 - d. “Aluminum-Framed Entrances and Storefronts”
 - e. “Entrances”
6. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.

1.02 REFERENCES

A. UL, ULC

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2019 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, “EXAMINATION” article, herein.
 - b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
3. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect’s hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.

- 5) Location of each hardware set cross-referenced to indications on Drawings.
- 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
- 7) Mounting locations for hardware.
- 8) Door and frame sizes and materials.
- 9) Degree of door swing and handing.

4. Key Schedule:

- a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
- b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
- c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
- d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
- e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
- f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Final approved hardware schedule edited to reflect conditions as installed.
 - d. Final keying schedule
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

E. Inspection and Testing:

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
 - a. fire door assemblies, in compliance with NFPA 80.
 - b. required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
 2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
 3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.
 - c. Can inspect and verify components are in working order upon completion of installation.
 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- B. Certifications:
1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
 2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
 3. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.
- C. Pre-Installation Meetings
1. Keying Conference
 - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Address for delivery of keys.

2. Pre-installation Conference

- a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Review required testing, inspecting, and certifying procedures.
- d. Review questions or concerns related to proper installation and adjustment of door hardware.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

1.06 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware and keying with Owner's security consultant.

WARRANTY

- C. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) 10 years
 - 2) Exit Devices
 - a) 10 years
 - 3) Closers

- a) 30 years
- 4) Overhead Stops
 - a) 10 years

1.07 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approval of alternate manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category are only to be considered by official substitution request in accordance in section 01 25 00.
- B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

- A. Fabrication
 - 1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer’s recognized installation standards for application intended.
 - 2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with “Metal Doors and Frames”, and “Flush Wood Doors” to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.03 HINGES

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product:

- a. Ives 5BB series
- 2. Acceptable Manufacturers and Products:
 - a. Hager BB1191/1279 series
 - b. Best FBB series
- B. Requirements:
 - 1. Provide hinges conforming to ANSI/BHMA A156.1.
 - 2. Provide five knuckle, ball bearing hinges.
 - 3. Provide hinge weights and sizes as specified in hardware sets.
 - 4. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
 - 5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
 - 6. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins

2.04 CONTINUOUS HINGES

- A. Manufacturers:
 - 1. Scheduled Manufacturer:
 - a. Ives
 - 2. Acceptable Manufacturers:
 - a. Select
 - b. ABH
- B. Requirements:
 - 1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
 - 2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
 - 3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
 - 4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
 - 5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
 - 6. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.05 FLUSH BOLTS

- A. Manufacturers:
 - 1. Scheduled Manufacturer:

- a. Ives
- 2. Acceptable Manufacturers:
 - a. Burns
 - b. DCI
- B. Requirements:
 - 1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.06 COORDINATORS

- A. Manufacturers:
 - 1. Scheduled Manufacturer:
 - a. Ives
 - 2. Acceptable Manufacturers:
 - a. Burns
 - b. DCI
- B. Requirements:
 - 1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
 - 2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes, or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.07 CYLINDRICAL LOCKS – GRADE 1

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product:
 - a. Schlage ND series (Owner Preferred)
 - 2. Acceptable Manufacturers and Products:
 - a. Sargent 11-Line
 - b. Corbin-Russwin CL3100 series
- B. Requirements:
 - 1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3-hour fire doors.
 - 2. Cylinders: Refer to “KEYING” article, herein.

3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2-inch latch throw. Provide proper latch throw for UL listing at pairs.
4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
 - a. Lever Design: Rhodes (RHO).

2.08EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Von Duprin 99/33A series (Owner Preferred)
2. Acceptable Manufacturers and Products:
 - a. Detex Advantex series
 - b. Precision APEX 2000 series

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide grooved touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer's approved strikes.
9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder dogging as specified at non fire-rated openings.
12. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
13. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.
14. Special Options:
 - a. SI: Provide dogging indicators for visible indication of dogging status.

2.09CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Exterior Doors: Schlage Everest 29 Primus XP, to match existing key system.
 - b. Interior Doors: Schlage Everest 29, to match existing key system.
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide cylinders for locking devices, whether called out in hardware sets or not.
2. Provide full-size interchangeable cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
3. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
 - a. Exterior: High Security, dual-locking cylinder with full size interchangeable core (FSIC) requiring restricted, patented keyway to match existing. Dual-locking mechanism with interlocking finger pin(s) to check for patented features on keys.
 - b. Interior: Patented Restricted cylinder with full size interchangeable core (FSIC) with patented, restricted keyway to match existing.
4. Patent Protection: Cylinders/cores requiring use of restricted, patented keys, patent protected.
5. Nickel silver bottom pins.

2.10KEYING

A. Scheduled System:

1. Existing factory registered system:
 - a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Construction Keying:
 - a. Replaceable Construction Cores.
 - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - a) 3 construction control keys
 - b) 12 construction change (day) keys.
 - 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.
2. Permanent Keying:

- a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - 1) Master Keying system as directed by the Owner.
- b. Forward biting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
- c. Provide keys with the following features:
 - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
- d. Identification:
 - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
 - 2) Identification stamping provisions must be approved by the Architect and Owner.
 - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
 - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- e. Quantity: Furnish in the following quantities.
 - 1) Change (Day) Keys: 3 per cylinder/core.
 - 2) Permanent Control Keys: 3.
 - 3) Master Keys: 6.

2.11 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. LCN 4040XP series (Owner Preferred)
2. Acceptable Manufacturers and Products:
 - a. Corbin-Russwin DC8000 series
 - b. Sargent 281 series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.

6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.12 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives.
2. Acceptable Manufacturers:
 - a. Trimco
 - b. Burns

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.13 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Burns
 - b. Trimco

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Provide protection plates with countersunk screw holes.
3. Size plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
4. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.14 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:
 - a. Glynn-Johnson
2. Acceptable Manufacturers:
 - a. Rixson
 - b. ABH

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

2.15 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Trimco
 - b. Burns

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.16 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Zero International
2. Acceptable Manufacturers:
 - a. National Guard
 - b. Reese

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.17 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Steelcraft
 - b. Republic

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.18 FINISHES

- A. Finish: Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 - 4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:
 - 1. Install construction cores to secure building and areas during construction period.
 - 2. Replace construction cores with permanent cores as indicated in keying section.
 - 3. Furnish permanent cores to Owner for installation.
- J. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- K. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- L. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- M. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- N. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- O. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer’s instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier’s responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

HARDWARE GROUP NO. 01

Provide each RU door(s) with the following:

QTY	DESCRIPTION NOTE	CATALOG NUMBER HARDWARE BY DOOR SUPPLIER	FINISH	MFR
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HARDWARE GROUP NO. 02

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ENTRANCE LOCK	ND53TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 03

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	ND70TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 04

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	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 05

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
2	EA	MANUAL FLUSH BOLT	FB458 24"	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	CLASSROOM LOCK	ND70TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 06

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
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 07

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	CLASSROOM LOCK	ND70TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4040XP EDA WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR BOTTOM	369AA	AA	ZER

HARDWARE GROUP NO. 08

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	CLASSROOM LOCK	ND70TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR BOTTOM	369AA	AA	ZER

HARDWARE GROUP NO. 09

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	CONST LATCHING BOLT	FB51P 24"	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	CLASSROOM LOCK	ND70TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	SURFACE CLOSER	4040XP EDA WMS	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
2	EA	DOOR BOTTOM	367AA	AA	ZER
1	EA	MEETING STILE	383AA	AA	ZER

HARDWARE GROUP NO. 10

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	OH STOP	90S	630	GLY
2	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	MEETING STILE	383AA	AA	ZER

HARDWARE GROUP NO. 11

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	PANIC HARDWARE	CDSI-99-NL	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	20-061 ICX 36-083	626	SCH
2	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4040XP SHCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HARDWARE GROUP NO. 12

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	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 13

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	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Operational Description: Doors normally closed and unlocked. Push/pull operation.

HARDWARE GROUP NO. 14

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY	628	IVE
1	EA	PANIC HARDWARE	CDSI-99-NL-OP-110MD	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	20-061 ICX 36-083	626	SCH
2	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

SEALS BY DOOR SUPPLIER

HARDWARE GROUP NO. 15

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB	689	VON
1	EA	PANIC HARDWARE	CDSI-99-EO	626	VON
1	EA	PANIC HARDWARE	CDSI-99-NL-OP-110MD	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
3	EA	MORTISE CYLINDER	20-061 ICX 36-083	626	SCH
4	EA	PRIMUS CORE	20-740-XP	626	SCH
2	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
2	EA	OH STOP	100S	630	GLY
2	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER
SEALS BY DOOR SUPPLIER					

END OF SECTION

SECTION 08 81 00 – GLASS GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes glazing for the following products and applications:
1. Windows. – See Window Specifications for aluminum window glazing.
 2. Doors.
 3. Glazed aluminum curtain walls.
 4. Glazed entrances.
 5. Interior borrowed lites.
 6. Aluminum-framed entrances and storefronts.
 7. Interior butt glazing

1.2 PERFORMANCE 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: Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. 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 and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 1. Specified Design Wind Loads: As indicated on drawings or if not indicated as required by local code.
 2. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - 1) Load Duration: 60 seconds or less.
 3. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm (1/4").
 4. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.
- D. Thermal Movements: Provide glazing that allows for thermal movements resulting from a maximum change (range) of 120 deg F, 180 deg F in ambient and surface temperatures, respectively, 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.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.

2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units with lites 6 mm (1/4") thick and a nominal 1/2-inch- wide interspace.
4. Center-of-Glass U-Values: NFRC 100 methodology using LBNL Window 6.3 computer program, expressed as Btu/ sq. ft. x h x deg F.
5. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBNL Window 6.3 computer program.
6. Solar Optical Properties: NFRC 300.

1.3 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Shop Drawings; Sealed by Delegated Design professional engineer.
- C. Samples: 12-inch- square, for each type of glass product indicated, other than monolithic clear float glass.
- D. Glazing Schedule: List glazing types and locations.
- E. Sealant compatibility and adhesion test reports.

1.4 QUALITY ASSURANCE

- A. Sealant Compatibility and Adhesion Testing: Use sealant manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
- B. Fire-Rated Assemblies: Where glazing products are used in fire-rated assemblies, comply with requirements of specific assembly specified in other sections of these Specifications.
 1. Door Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252. Fire-rated glazing in doors must be tested to ASTM E 119 or UL 263 and NFPA 252, UL 10B or UL 10C, per NCBC 716.5.8.1.1.
 2. Window Assemblies: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
 3. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.
- C. Glazing Publications: Comply with recommendations of the following, unless more stringent requirements are indicated.
 1. GANA Publications: "Glazing Manual" and "Laminated Glass Design Guide."
 2. SIGMA Publications: SIGMA TM-3000, "Vertical Glazing Guidelines."

- D. Insulating-Glass Certification Program: Permanently marked with certification label of one of the following: Insulating Glass Certification Council, Associated Laboratories, Inc National Accreditation and Management Institute.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form, made out to Owner and signed by manufacturer, in which manufacturer agrees to furnish replacements for units that deteriorate from normal use by developing defects attributable to the manufacturing process, f.o.b. the nearest shipping point to Project site, within warranty period.
1. Coated Glass:
 1. Defects: Peeling, cracking, and other indications of degradation of metallic coating.
 2. Warranty Period: 10 years from date of Final Acceptance.
 2. Laminated Glass:
 1. Deterioration: Edge separation, delamination that materially obstructs vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 2. Warranty Period: Five years from date of Final Acceptance.
 3. Insulating Glass:
 1. Deterioration: Failure of hermetic seal resulting in obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 2. Warranty Period: 10 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 GLAZING MATERIALS

A. INSULATING GLASS UNITS

- 1) General: Insulating-Glass Units; Basis of Design: SN68 on Clear by Guardian Sunguard (u.n.o.).
 - Pre-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190 and complying with requirements designated below, indicated on Drawings, or required by building code.
 - Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in "Performance Requirements" Article.
 - Sealing System: Dual seal with manufacturers standard primary and secondary sealants.
 - Spacer: Manufacturer's standard.
 - Corner Construction: Manufacturer's standard.
 - Overall Unit Thickness and Thickness of Each Lite: 25 mm (1") and 6 mm (1/4") Dimensions indicated are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.

Interspace Content: Air.
- 2) Glass **Type G-1**: Fire-rated Clear Fully Tempered Float Glass: reference Spec 08 81 13 for glazing material.
- 3) Glass **Type G-2** Low-E Tinted Tempered Insulating Glass: SN 68 on Clear
 1. Provide glass complying with requirements designated below, indicated on drawings, or required by building code. Interspace Content: Air
 2. Indoor Lite: Float glass, Class 1 (clear) Kind FT (fully tempered)

3. Outdoor Lite: Float glass, Class 2 (clear), Kind FT (fully tempered)
 4. Double-Silver Coating
 5. Low-Emissivity Coating: Coating on third surface.
 6. Winter Nighttime U-Value: Maximum value of .29 unless otherwise noted
 7. Summer Daytime U-Value: Maximum value of .28 unless otherwise noted
 8. Visible Light Transmission: 68%
 9. SHGC: .38
 10. Shading Coefficient: 0.43
 11. Outdoor Visible Light Reflectance: 11%
- 4) Glass **Type G-3** Low-E Tinted Insulating Glass: SN 68 on Clear
1. Provide glass complying with requirements designated below, indicated on drawings, or required by building code. Interspace Content: Air
 2. Indoor Lite: Float glass, Class 1 (clear)
 3. Outdoor Lite: Float glass, Class 2 (clear)
 4. Double-Silver Coating
 5. Low-Emissivity Coating: Coating on third surface.
 6. Winter Nighttime U-Value: Maximum value of .29 unless otherwise noted
 7. Summer Daytime U-Value: Maximum value of .28 unless otherwise noted
 8. Visible Light Transmission: 68%
 9. SHGC: .38
 10. Shading Coefficient: 0.43
 11. Outdoor Visible Light Reflectance: 11%
- 5) Glass **Type G-4** Spandrel Insulated 1" Glass Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B (spandrel glass, one-surface ceramic coated), Type I (transparent glass, flat), Quality q3 (glazing select),
1. Interspace Content: Air
 2. Float glass, Class 2 tinted, heat absorbing and light reducing.
 3. Tint Color: Color to be selected by Architect

2.2 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will 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.
 2. Colors of Exposed Sealants: As selected by Architect from manufacturer's standard colors.
- B. Elastomeric Glazing Sealants: ASTM C 920, Type S (single component), Grade NS (nonsag), Class 25, Use NT (nontraffic), M, G, A, and, as applicable to glazing substrates indicated, O.
1. Glazing Sealant for Fire-Resistive Glazing Products: Sealant used in test assembly to obtain fire-protection rating.
 2. Low-Modulus Nonacid-Curing Silicone: With additional movement capability of 50 percent movement in extension and 50 percent movement in compression when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719.
 3. Medium-Modulus Neutral-Curing Silicone: With additional movement capability of 50 percent movement in extension and 50 percent movement in compression when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719.

- C. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
- D. Abutment Strip;
 - 1. Provide C.R. Laurence EZCE12 clear polymer strip or equal for abutted glass joints as required.

2.3 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tape: Closed-cell, PVC foam tape; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
 - 1. Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.4 GLAZING GASKETS

- A. Compression Gaskets: Molded or extruded gaskets of type and material indicated below and of profile and hardness required to maintain watertight seal:
 - 1. Neoprene or EPDM dense compression gaskets complying with ASTM C 846.
 - 2. Silicone dense compression gaskets complying with ASTM C 1115.
 - 3. Neoprene, EPDM, or Silicone soft compression gaskets complying with ASTM C 509, Type II, black.

2.5 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

- F. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.
- G. Provide tapered bottom rail and top channel for ½” tempered glass wall system as listed below:
 - 1. Bottom Rail: 4” High and 2” High see Drawings. Clear Satin Anodized Square Bottom Rail with setting block and ¼” saddle bottom -CR Laurence Arch Products #SR4SSA3812SL or equal.
 - 2. Top Rail: 1 5/8” x 1 5/8” Clear Satin Anodized U-Channel - CR Laurence Arch Products #UCSA3812SL or equal.

2.6 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products in sizes required to glaze 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 standard, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- 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 referenced glazing publications.
 - 1. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
 - 2. Protect glass edges from damage during handling and installation. Remove glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance from Project site and legally dispose of off Project site.
 - 3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by sealant compatibility and adhesion testing.
 - 4. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
 - 5. Provide spacers for glass lites where the length plus width is larger than 50 inches unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances.
- B. Protection:
 - 1. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface.
 - 2. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter.
- C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged, including natural causes, accidents, and vandalism, during construction period.

SECTION 08 81 13 – FIRE-RATED GLAZING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Fire rated glazing
 - 1. Fire resistive, safety rated glazing material for interior and exterior applications.
 - 2. Applications of fire rated glazing includes:
 - a. Fire rated glazing as windows in fire rated frames.
- B. Related sections:
 - 1. Section 01 33 23: Shop Drawings, Product Data and Samples
 - 2. Section 08 80 00: Glazing
 - 3. Section 08 11 13: Hollow Metal Doors and Frames
 - 4. Section 08 11 16: Aluminum Doors and Frames
 - 5. Section 08 44 13: Glazed Aluminum Curtain Walls

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM E119: Methods for Fire Tests of Building Construction and Materials.
 - 2. ASTM E152: Methods for Fire Tests of Door Assemblies.
 - 3. ASTM E163: Methods for Fire Tests of Window Assemblies.
 - 4. ASTM E2074: Standard Test Method for Fire Tests of Door Assemblies, including Positive Pressure Testing of Side-hinged and Pivoted Swinging Door Assemblies.
 - 5. ASTM E2010-1: Standard Test for Positive Pressure of Fire Tests of Window Assemblies.
- B. National fire Protection Association (NFPA):
 - 1. NFPA 80: Fire Doors and Windows.
 - 2. NFPA 251: Fire Tests of Building Construction and Materials.
 - 3. NFPA 252: Fire Tests of Door Assemblies.
 - 4. NFPA 257: Fire Tests of Window Assemblies.
- C. Underwriters Laboratories, Inc. (UL):
 - 1. UL 9: Standard for Safety of Fire Tests of Window Assemblies.
 - 2. UL 10 B: Standard for Safety of Fire Tests of Door Assemblies.
 - 3. UL 10 C: Standard for Safety of Positive Pressure Tests of Door Assemblies.
 - 4. UL 263: Fire Tests of Building Construction and Materials.
- D. Standard Council of Canada:
 - 1. ULC Standard CAN4-S101: Fire Tests of Building Construction and Materials.
 - 2. ULC Standard CAN4-S104: Fire Tests of Door Assemblies.
 - 3. ULC Standard CAN4-S106: Fire Tests of Window Assemblies.
- E. Consumer Product Safety Commission (CPSC):
 - 1. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials.
- F. Glass Association of North America (GANA)

1. GANA – Glazing Manual.
2. FGMA – Sealant Manual.

G. National Fenestration Rating Council (NFRC)

1. NFRC 100: Procedure for Determining Fenestration Product U-Factors.
2. NFRC 200: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

1.03 SYSTEM DESCRIPTION

- A. Performance Requirements: Provide a fire rated glazing manufactured, fabricated and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
1. Fire Rating: 120 minutes with hose stream.
 2. Fire resistive, safety rated glazing tested in accordance with ASTM E119, NFPA 80, NFPA 251, NFPA 252, NFPA 257, UL 9, UL 10B, UL 10C and UL 263.
 3. Testing Laboratory: Fire tests shall be conducted by a nationally recognized independent testing laboratory.
- B. Listings and Labels:
1. Fire rated glazing shall be under current follow-up services by a nationally recognized independent testing laboratory approved by OSHA and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.

1.04 SUBMITTALS

- A. Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedure Section.
1. Shop Drawings: Submit shop drawings showing layouts, profiles and product components.
 2. Technical Information: Submit latest edition of manufacturer's product data.

1.05 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 Product Requirements Sections.
- B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- C. Delivery: Deliver materials to specified destinations in manufacturer or distributor's packaging.
- D. Storage and Protection: Store off ground, under cover, protected from weather and construction activities and at temperature conditions recommended by manufacturer.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify actual measurements for openings by field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.07 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. Manufacturer's warranty is not intended to limit other rights that the Owner may have under the Contract Documents.
 - 1. Warranty Period: 5-year limited warranty from date of shipping.

PART 2 PRODUCTS

2.01 FIRE RATED GLAZING

- A. Material: SuperLite® II-XL 120 minute fire resistive glazing with hose stream (basis of design).
- B. Manufacturer: SuperLite® II-XL as manufactured and distributed by SAFTI *FIRST*®.
 - 1. Contact: 100 N Hill Drive, Suite 12, Brisbane, CA 94005; Telephone 888.653.3333; email info@safti.com; Web site www.safti.com.
 - 2. Fire rated glass and framing must be provided by a single-source, US manufacturer. Distributors of fire rated glass and framing are not to be considered as manufacturers.
 - 3. Acceptable manufacturers: Fyre-Tec Fire-Rated Windows, Technical Glass Products FireLite Plus, or approved equal.
- C. Design Requirements:
 - 1. Make-up: Must be comprised of an inboard and outboard lite of clear tempered glass protecting a clear, fire resistive, intumescent interlayer.
 - 2. Thickness: 1-3/4" (45 mm) standard profile.
 - 3. Weight: 16 lbs/sq. ft. in 1-3/4" (45 mm) standard profile.
 - 4. Sound Transmission Rating: Must meet 44 STC/40 OITC in 1-3/4" standard profile; Must meet 44 STC/ 37 OITC insulated with 1/4" Low-E.
 - 5. Dimensions: as indicated on drawings.
 - 6. Appearance: Must be tint-free, optically clear fire rated glazing.
 - 7. Visible Light Transmission: Must meet 0.777 with clear tempered.
 - 8. Fire Rating: Must be fire rated to 120 minutes with hose stream and meet ASTM E-119.
 - 9. Impact Safety Resistance: CPSC 16 CFR 1201 Cat. I & II.
 - 10. Hard Body Impact Classification: Must meet ASTM C1629/C1629M Level 3.
 - 11. Soft Body Impact Classification: Must meet ASTM E695 Level 3.
 - 12. Surface Abrasion Resistance: Must meet ASTM D4977 Level 3.
- D. Manufacturer's Fire Rating Glazing Material:
 - 1. Each piece of fire-rated glazing material shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory, fire rating period and safety glazing standards.
 - 2. Glazing materials installed in Hazardous Locations, subject to human impact, shall be certified and permanently labeled as meeting applicable requirements reference in NFPA 80:
 - a. CPSC 16 CFR 1201 Cat. I & II

2.02 MATERIALS

- A. Glazing Accessories: Manufacturer recommended fire rated glazing accessory as follows:
 - 1. Glazing with EPDM tape or other listed flame resistant gasket material and calcium silicate setting blocks.

2.03 RELATED PRODUCTS

- A. Glazing shall be installed in an equally rated framing system.
- B. Pressure glazing is allowed.

2.04 SOURCE QUALITY

- A. Obtain fire rated glazing products from a single manufacturer.
- B. Fabrication Dimensions: Fabricate to approved dimensions. The general contractor shall guarantee dimensions where practicable within required tolerances.

PART 3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data including product technical bulletins and installation instructions.

3.02 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions, have been previously installed under other sections, and are acceptable for product installation in accordance with manufacturer's instructions.

3.03 INSTALLATION

- A. Installation shall be in strict accordance with the fire glazing material manufacturer's specifications. Field cutting or tampering is strictly prohibited.

3.04 CLEANING AND PROTECTION

- A. Protect glass from contact with contaminating substances resulting from construction operations. Remove such substances by method approved by manufacturer.
- B. Wash glass on both faces not more than four days prior to date schedule for inspections intended to establish date of Substantial Completion. Wash glass by method recommended by glass manufacturer.
- C. Remove temporary coverings and protection of adjacent work areas.
- D. Remove construction debris from project site and legally dispose of debris.

END OF SECTION

Division 09 - Finishes

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 1. Interior gypsum wallboard.
 2. Exterior gypsum sheathing board.
 3. Tile backing panels.
 4. Non-load-bearing steel framing.
 5. Weather-resistant sheathing paper.

1.2 SUBMITTALS

- A. Product Data: For each product indicated.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 STEEL FRAMING

- A. Steel Framing, General: Comply with ASTM C 754 for conditions indicated.
 1. Steel Sheet Components: Metal complying with ASTM C 645 requirements.
 - a. Protective Coating:
 - 1) Interior Applications: ASTM A 653, G40, hot-dip galvanized zinc corrosion-resistant coating.
 - 2) Exterior Applications: ASTM A 653/A 653M, G60, hot-dip galvanized zinc corrosion-resistant coating.
- B. Suspended Ceiling and Soffit Framing:
 1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.
 2. Hanger Attachments to Concrete if required:
 - a. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.
 3. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

4. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2-inch-wide flange, and in depth indicated.
5. Furring Channels (Furring Members):
 - a. Cold Rolled Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch-wide flange, 3/4 inch deep.
 - b. Steel Studs: ASTM C 645, in depth indicated.
 - 1) Minimum Base Metal Thickness: 0.0179 inch
 - c. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep, unless indicated otherwise.
 - 1) Minimum Base Metal Thickness: 0.0179 inch
 - d. Resilient Furring Channels: As noted on drawings, 1/2-inch-deep members designed to reduce sound transmission, and asymmetrical with single leg.
- C. Grid Suspension System for Interior Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Products:
 - a. Armstrong World Industries, Inc.; Furring Systems/Drywall.
 - b. Chicago Metallic Corporation; Drywall Furring System.
 - c. USG Interiors, Inc.; Drywall Suspension System.
- D. Partition and Soffit Framing: All thicknesses are minimums; verify if drawings call for specific gauge.
 1. Steel Studs and Runners: ASTM C 645, in depth indicated.
 - a. Minimum Base Metal Thickness: 0.0179 inch.
 2. Deflection Design Options:
 - a. Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs. Refer to manufacturer's recommendations for use in axial load-bearing stud conditions or above continuous window spandrels.
 - 1) Deep-Leg Deflection Track: ASTM C 645 top runner with 2-inch deep flanges. Requires U-Channels and angles installed continuously throughout the uppermost punch-outs to align the studs vertically within the plane of the wall.
 - 2) Slotted Deflection Track: ASTM C 645 Top runner with 2 1/2" deep flanges with vertical slots.
 3. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - a. Minimum Base Metal Thickness: 0.0179 inch.
 4. Cold-Rolled Channel Bridging: 0.0538-inch bare steel thickness, with minimum 1/2-inch-wide flange, and in depth indicated.
 - a. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch-thick, galvanized steel.
 5. Hat-Shaped, Rigid Furring Channels: ASTM C 645, in depth indicated.
 - a. Minimum Base Metal Thickness: 0.0179 inch
 6. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission. Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs.
 7. Cold-Rolled Furring Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch-wide flange, and in depth indicated.
 - a. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch.
 - b. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch-diameter wire, or double strand of 0.0475-inch diameter wire.

8. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
9. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.

2.2 PANEL PRODUCTS

- A. Panel Size, General: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 1396.
 1. Regular Type: In thickness indicated and with long edges tapered and featured (rounded or beveled).
 2. Type X: In thickness indicated and with long edges tapered and featured (rounded or beveled).
- C. Flexible Gypsum Wallboard: ASTM C 1396, manufactured to bend to fit tight radii and to be more flexible than standard regular-type panels of the same thickness, 1/4 inch thick, and with long edges tapered. Apply in double layer at curved assemblies.
- D. Impact Resistant Gypsum Wallboard: 5/8 inch thick High Performance Glass Mat Panels complying with ASTM C1629 level 3, ASTM C1658, ASTM C1396 section 7 and ASTM E136, Glass-Mat moisture and mold resistant interior panels manufactured with greater surface indentation and impact resistance than Abuse Resistant panels.
 1. Products:
 - a. United States Gypsum Co SHEETROCK Brand Glass-Mat Panels Mold Tough VHI
 - b. National Gypsum eXP Interior Extreme IR Gypsum Panel
- E. Abuse-Resistant Gypsum Wallboard: ASTM C 1396, manufactured to produce greater resistance to surface indentation and through-penetration than standard gypsum panels, with core type and in thickness indicated, and with long edges tapered.
 1. Products:
 - a. National Gypsum Company; Gold Bond Hi-Abuse Wallboard.
 - b. United States Gypsum Co.; SHEETROCK Brand Abuse-Resistant Gypsum Panels.
- F. Exterior Gypsum Sheathing Panels for Walls, Parapets, Ceilings and Soffits:
 1. Exterior Glass-Mat Gypsum Soffit and Ceiling Board: ASTM C 1396/C 1396M and C 1177/C 1177M, with core type and in thickness indicated and with manufacturer's standard edges.
 - a. Product: G-P Gypsum Corp; Dens-Armor Plus. Install manufacturer's recommended taping system over joints.
 2. Glass-Mat Gypsum Sheathing Board (exterior walls): ASTM C 1177/C 1177M, with core type and in thickness indicated.
 - a. Products:
 - 1) G-P Gypsum Corp; Dens-Glass Gold. Install manufacturer's recommended taping system over joints.
 - 2) CertainTeed Gypsum; GlasRoc high-performance sheathing. Install manufacturer's recommended taping system over joints.
 - 3) United States Gypsum Co.; SECUROCK Glass-mat sheathing. Install manufacturer's recommended taping system over joints.

3. Glass-Mat Gypsum Sheathing Board (roof side of parapets): ASTM C 1177/C 1177M, with core type and in thickness indicated.
 - a. Product: G-P Gypsum Corp; Dens-Deck Roof Board.
 - b. United States Gypsum Co.; SECUROCK Glass-Mat Roof Board.

G. Tile Backing Panels:

1. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M, with core type and in thickness indicated.
2. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with core type and in thickness indicated.
 - a. Product: G-P Gypsum Corp.; Dens-Shield Tile Backer.
 - b. Product: CertainTeed Gypsum; DiamondBack Tile Backer.
 - c. Or approved equal.

- H. Recycled Content of Panels: Provide gypsum panel products with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 95 percent by weight.

2.3 TRIM ACCESSORIES

A. Interior Trim:

1. Paper Faced Corner Beads and Trim
 - a. Corner Beads shall be premanufactured, reinforced paper face corner beads with continuous co-polymer core with perforated edges as manufactured by No-Coat or metal facing with perforated paper edges as manufactured by USG
2. Expansion (Control) Joint: Use as noted below and where indicated on drawings.
 - a. Ceilings
 - 1) Install control joints in areas exceeding 2500 sq. ft. (232 sq. m).
 - 2) Space control joints not more than 50 feet (15.2 m) o.c.
 - 3) Install control joints where ceiling framing or furring changes direction.
 - b. Partitions and Furring
 - 1) Install control joints in partitions and wall furring runs exceeding 30 feet.
 - 2) Space control joints not more than 30 feet o.c.
 - 3) Install control joints in furred assemblies where control joints occur in base exterior wall
3. Curved-Edge Corner bead: With notched or flexible flanges; use at curved openings.

B. Exterior Trim: ASTM C 1047, hot-dip galvanized steel sheet or rolled zinc.

1. Corner bead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.
3. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening. Use as noted below and where indicated on drawings.
 - a. Ceilings
 - 1) Install control joints in areas exceeding 2500 sq. ft. (232 sq. m).
 - 2) Space control joints not more than 50 feet (15.2 m) o.c.
 - 3) Install control joints where ceiling framing or furring changes direction.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Products:
 - a. Fry Reglet Corp.; As indicated by designation on Drawings
 - b. Gordon, Inc.; As indicated by designation on Drawings

- c. MM Systems Corporation; As indicated by designation on Drawings
- d. Pittcon Industries; As indicated by designation on Drawings
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified

2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 1. Interior Gypsum Wallboard: Paper.
 2. Glass-Mat Gypsum Soffit Board: As recommended by panel manufacturer.
 3. Glass-Mat Gypsum Sheathing Board: As recommended by panel manufacturer.
 4. Tile Backing Panels: As recommended by panel manufacturer.
- 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, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, flanges of trim accessories, and fasteners, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 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 Exterior Applications:
 1. Glass-Mat Gypsum Soffit Board: As recommended by manufacturer.
 2. Glass-Mat Gypsum Sheathing Board: As recommended by manufacturer.
- E. Joint Compound for Tile Backing Panels:
 1. Water-Resistant Gypsum Backing Board: Use setting-type taping and setting-type, sandable topping compounds.
 2. Glass-Mat, Water-Resistant Backing Panel: As recommended by manufacturer.
 3. Cementitious Backer Units: As recommended by manufacturer.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. Products:
 - a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - c. Owens Corning, Quiet Zone Acoustical Sealant

- C. Acoustical Sealant for Concealed Joints: Nondrying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.
 - 1. Products:
 - a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
 - b. Pecora Corp.; BA-98.
 - c. Tremco, Inc.; Tremco Acoustical Sealant.
- D. VOC content of Acoustical Sealants
 - 1. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. 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.
- F. Sill Seal at Exterior Walls:
 - 1. Sill Seal: Provide flexible polyethylene foam gasketing strip between concrete foundation and sill plate. Strip shall be .25" x 5.5" for 6" metal stud walls. Provide "Weathmate Sill Seal" by Dow Building Solutions or equal.
- G. Sound Attenuation Blankets: Refer to Division 07 Section "Blanket Insulation".
 - 1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 NON-LOAD-BEARING STEEL FRAMING INSTALLATION

- A. General: Comply with ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintain continuity of fire and sound isolation construction.
- C. Seal construction with acoustical sealant at perimeter of each assembly, where it abuts other work, behind control joints and at openings/penetrations.
 - 1. Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
- D. Suspended Ceiling and Soffit Framing:
 - 1. Suspend ceiling hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in

form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

3. Attach hangers to structural members. Do not support ceilings from or attach hangers to permanent metal forms, steel deck tabs, steel roof decks, ducts, pipes, or conduit.
4. Screw furring to framing.
5. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.
6. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Partition and Soffit Framing:

1. Where studs are installed directly against exterior walls, install isolation strip between studs and wall.
2. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
3. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb, with three straps unless otherwise indicated.
4. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

F. Z-Furring Members: Erect insulation vertically and hold in place with Z-furring members.

3.2 PANEL PRODUCT INSTALLATION

A. Gypsum Board: Comply with ASTM C 840 and GA-216.

1. Space fasteners in panels that are tile substrates a maximum of 8 inches on center.
2. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
3. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
4. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
5. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
6. Multilayer Fastening Methods: Fasten base layers; and face layers separately to supports with screws; fasten face layers with adhesive and supplementary fasteners; or, as required to comply with requirements for fire-resistance-rated assemblies indicated.

- B. Exterior Ceilings and Soffits: Apply exterior gypsum panels perpendicular to supports, with end joints staggered and located over supports.
 - 1. Fasten with corrosion-resistant screws.
- C. Tile Backing Panels:
 - 1. Cementitious Backer Unit Application: ANSI A108.11.

3.3 FINISHING

- A. Installing Trim Accessories: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Finishing Gypsum Board Panels: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
 - 1. Prefill open joints, rounded or beveled edges, and damaged surface areas.
 - 2. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
 - 3. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
 - 4. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.
- C. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840 and GA 214, for locations indicated:
 - 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.
 - 3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges of all panel surfaces that will be exposed to view, unless Level 5 finish is otherwise indicated.
 - 4. Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges and apply a final skim coat over the entire surface of panels that will be exposed to view. Use Level 5 for gypsum panel surfaces to be finished with gloss, semi-gloss or enamel paint unless otherwise indicated.

END OF SECTION 09 21 16

SECTION 09 30 00 - TILING

PART 1 - GENERAL

1.01 SUMMARY:

- A. Provide all of the labor, materials, equipment and services to furnish and install the tile and accessories as indicated on the Drawings and as specified herein.
- B. This section includes the following:
 - 1. Porcelain tile
 - 2. Waterproof membrane.
 - 3. Crack-isolation membrane.
 - 4. Tile backing panels.
 - 5. Metal edge/transition.

1.02 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.
- D. Face Size: Actual tile size, (minor facial dimension as measured per ASTM C 499) excluding spacer lugs.

1.03 PERFORMANCE REQUIREMENTS

- A. Dynamic Coefficient of Friction: For tile installed on walkway, surfaces, provide products that meet the requirements of ANSI A137.1-2012 testing method, the DCOF Acu Test.
 - 1. Minimum DCOF: 0.42 for level interior spaces expected to be walked upon when wet.

1.04 PRE-INSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.05 QUALITY ASSURANCE:

- A. In addition to complying with all pertinent codes and regulations, comply with the following:
 - 1. "Handbook for Ceramic Tile Installation" (latest edition) as published by the Tile Council of America, Inc., TCNA.
 - 2. "American National Standard Specifications for Ceramic Tile" (ANSI 108 Series of tile installation and in ANSI 137.1 and A137.3-latest edition).
 - 3. ANSI Specifications: American National Standard Specification for Installation of Ceramic Tile. Reference number is at specific installation area.

- B. **Tile contractor, by commencing the work of this section, assumes overall responsibility to assure that all assemblies, components and parts shown or required within the work of this section comply with contract documents and are compatible with each other and with the conditions and expected use.**
- C. Pre-Installation Meeting: Prior to tile installation, conduct a pre-installation project meeting. Contractor, Subcontractor, Material Suppliers, Manufacturer representative, Architect and Owner Representative shall be notified of the meeting.
- D. Source Limitations for Tile: Obtain all tile and Setting and Grouting Material from one source.
- E. Source Limitations for Setting and Grouting Material: obtain ingredients of a uniform quality for each mortar, adhesive and grout component from a single manufacturer and each aggregate from one source.
- F. Source Limitations for other Products: Obtain each of the following products specified in this section through one source from a single manufacturer. If manufacturer has products in multiple categories, then that manufacturer must be used for all.
 - 1. Stone Thresholds
 - 2. Waterproofing
 - 3. Joint Sealants or Movement Joint Profiles
 - 4. Metal edge strip
 - 5. Uncoupling or Anti-Fracture Membrane
- G. Installer Qualification: Engage an installer that has a minimum of five years' commercial experience with tile installations similar in material, design and scope to that indicated.

1.06 SUBMITTALS:

- A. Prior to installation, submit to the Architect for review the following:
 - 1. Physical samples:
 - a. Tile and tile accessory pieces: Submit two (2) samples of each type and color specified.
 - b. Grout.
 - c. Metal edge strips in 6-inch lengths.
 - 2. Master Grade Certificate, signed by an officer of the firm manufacturing the tile used, and issued when the shipment is made, stating the grade, kind of tile, identification marks for tile containers, and the name and location of the Project.
- B. Maintenance and operation manual: Submit tile manufacturer's maintenance guides for Owner's use in maintaining all tile herein specified.
- C. Shop Drawings: Show location 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.
- D. Product Data: For each product indicated.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, plus other information specified.

1.07 PRODUCT HANDLING:

- A. Deliver all materials of this Section to the job site in their original unopened containers with all labels intact and legible at time of use.

1.08 EXTRA MATERIALS:

- A. Deliver extra materials to Site. Furnish extra materials described below that match products installed, and are packaged with protective covering for storage, and are identified with labels describing contents, name of project and the project's address.
 - 1. Tile and Trim Units: Furnish **1 box** of full size units for each type, composition, color, pattern, and size indicated.
 - 2. This material shall not be available to the Contractor for replacement goods within the Contractor's General Warranty period for the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, 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 a comparable product aesthetically closely matching, as well as listed performance characteristics of another name or unnamed 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 following requirements:
 - 1. As selected by Architect from manufacturer's full range.
- 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. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.
1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.03 FLOOR TILE PRODUCTS

- A. Manufacturers:
1. Florida Tile Inc.
 2. Dal tile; Div. of Dal-Tile International Inc.
 3. BestTiles
- B. TYPICAL FLOOR TILE – “PT-1” & “B-2” UNGLAZED PORCELAIN TILE:
1. **PT-1 Basis-of-Design:** Florida Tile; Divinity, product # FTIDIV10112x24, Color-Dawn
 2. **B-2 Basis-of-Design:** Florida Tile; Divinity product # P43C9-AT, color- Dawn, Bullnose base on top of floor tile.
 3. **Grout: GR-2** Laticrete, spectralock pro premium – Epoxy floor grout, #60 dusty grey
 4. **Composition:** U.S. manufacturer, unglazed color body, rectified porcelain tile. Impervious body, tile with 1/2% absorption. 40% pre-consumer recycle content.
 5. **Size: PT-1:** 12” X 24”, **B-2:** 3” X 24” bullnose.
 6. **Thickness:** 10 mm
 7. **Face:** Natural
 8. **DFOC:** Not less than 0.42
 9. **Breaking Strength:** 500 lbf. Avg.
 10. **Installation Pattern:** Grid Pattern
 11. **Installation:** TCNA F125 Full Spread and ANSI A108.1B for LFT/LHT Medium Bed.

2.04 WALL TILE PRODUCTS

- E. WALL TILE – “WT-1” GLAZED PORCELAIN WALL TILE:
1. **WT-1 Basis-of-Design:** Florida Tile; Aventis, product # FTIAT3RF12x24, color Titanium
 2. **TR-1 Basis-of-Design:** Schluter; DILEX-AHK, color: stainless steel. Cove floor to wall tile. See detail 01/A705.
 3. **Grout: GR-2,** Spectralock Premix– Epoxy wall grout, #60 Dusty Grey.
 4. **Composition:** U.S. manufacturer, high definition glazed color body porcelain tile, with Microban. Impervious body, tile with .5% absorption. 40% pre-consumer recycle content.
 5. **Size: WT-1:** 12” X 24”.

6. **Thickness:** 10 mm
7. **Face:** Surface Hardness 7 Mohs
8. **DFOC:** Not less than 0.42
9. **Breaking Strength:** 490 lbf. Avg.
11. **Installation Pattern:** Grid stacked pattern
12. **Installation:** TCNA W202I for LFT/LHT Medium Bed Plus – no sag.

2.05 TILE ACCESSORIES & TRIM:

- A. Tile Trim: Size, color and shade to match selected tile as required.
 1. Wainscot cap: Bull nose, except provide regular glazed flat tile where tile wall surface is flush with finished wall surface above.
 2. Inner corners: Square
 3. Outer corners: Bull nose
 4. Jambs: Bull nose where tile work projects from jamb
 5. Cove base: Flat-top cove base with inside and outside corners where appropriate/specified or TR-1 Basis-of-Design: Schluter: DILEX-AHK, color; stainless steel, cove floor to wall tile as listed. See detail 01/A710
 6. Installation Type: TCNA Method W223 thinset. Adhesive as recommended by manufacturer.

- B. METAL FINISHING AND EDGE PROTECTION PROFILE FOR WALLS
 1. **Description:** TR-4, Basis-of-Design- Schluter- Jolly; L-shaped profile with 1/8 inch (3.2 mm) wide top section vertical wall section that together form the visible surface, integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.

 2. **Description:** TR-1, Basis-of-Design- Schluter- Dilex; Schluter; profile with square visible surface, integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.
 - a. Provide with matching inside corners.
 - b. Provide with matching outside corners.

2.06 TILE BACKING PANELS:

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, Type A, in maximum lengths available to minimize end to end butt joints.
 1. Thickness: 5/8"

2.07 CRACK ISOLATION MEMBRANE / UNCOUPLING MEMBRANE:

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10/ANSI A118.12 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer. Provide 125 full spread on grade slab and F128 on 2nd floor and above and all full coverage applications.

- B. F125 Full Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 1. Basis-of-Design Products: Subject to compliance with requirements, provide

“Mapelastic CI” crack-isolation membrane as manufactured by Mapei Corporation or comparable product offered by one of the following:

- A. Custom Building Products.; “RedGard Waterproofing and Crack Prevention Membrane.”
- B. Laticrete International, Inc.; “Hydro Ban.”

C. UNCOUPLING MEMBRANE

- 1. F 113A: Uncoupling Membrane: Basis of Design: Schluter Systems L.P, Ditra, DitraXL or Ditra Duo.
Uncoupling Membrane: Description: 1/8 inch (3 mm) thick, orange, high-density polyethylene membrane with a grid structure of 1/2 inch by 1/2 inch (12 mm by 12 mm) square cavities, each cut back in a dovetail configuration, and a polypropylene anchoring fleece laminated to its underside. Conforms to definition for uncoupling membranes in the Tile Council of North America Handbook for Ceramic Tile Installation and is listed by cUPC to meet or exceed the requirements of the "American national standard specifications for load bearing, bonded, waterproof membranes for thin-set ceramic tile and dimension stone installation A118.10 and is listed by cUPC, and is evaluated by ICC-ES (see Report No. ESR-2467).
- 2. Waterproofing seaming membrane:
 - a. Provide Seams and Corners material 0.004 inch (0.1 mm) thick, orange polyethylene membrane, with polypropylene fleece laminated on both sides.

2.09 INSTALLATION TYPE - SETTING BED:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Laticrete International, Inc.
 - 2. MAPEI Corporation.
 - 3. TEC; H.B. Fuller Construction Products Inc.
 - 4. Bonsal American, an Oldcastle company.
- B. High-Performance Latex-Portland Cement Mortar (Thinset): ANSI A118.15.
 - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15.
- C. High-Performance Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.15. Provide product that is approved by manufacturer for application thickness of 3/4 inch.
 - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
- E. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Custom Building Products; CEG Lite.
 - b. Laticrete International Inc.; SpectraLock Pro Premium.
 - c. MAPEI Corporation; Kerapoxy.

- d. TEC: H.B. Fuller Construction Products Inc. ; Accucolor EFX mortar.
2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.10 GROUT:

- A. A. High-Performance Tile Grout: ANSI A118.7.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARDEX Americas.
 - b. Custom Building Products; Prism.
 - c. Laticrete International Inc.; Perm color Select.
 - d. MAPEI Corporation; Ultra color Plus.
 - e. TEC: H.B. Fuller Construction Products Inc.; Power Grout.
 2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
 3. Color: As selected by Architect from manufacturer's full range.
- B. Water-Cleanable Epoxy Grout: ANSI A118.3.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Custom Building Products; CEG Lite.
 - b. Laticrete International, Inc.; Spectralock Pro Premium.
 - c. MAPEI Corporation; Kerapoxy.
 - d. TEC: H.B. Fuller Construction Products Inc.; Accucolor EFX.
 2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.11 THRESHOLD & TRANSITIONS:

- A. Marble: White Carrara, polished exposed surface; Marble threshold shall be 2" wide and of a thickness appropriate for thin-set application
- B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications, stainless steel; ASTM A 666, 300 Series exposed-edge material.
 1. Description: Basis of Design: Schluter Systems L-shaped profile with 1/8 inch (3.2 mm) wide visible surface integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.
 2. Description: Basis of Design: Schluter Systems profile with sloped exposed surface, 1/4 inch (6 mm) deep channel below exposed surface, integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.
 3. Description: Basis of Design: Schluter Systems profile with sloped exposed surface, 5/32 inch (4 mm) tall leading edge, integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.

2.12 MOVEMENT JOINTS AND COVE-SHAPED PROFILES

- A. Description: Basis of Design: Schluter Systems L.P: "DILEX" profile with integrated aluminum, trapezoid-perforated anchoring legs, connected by grip bars to a 1/4 inch (6 mm) wide soft PVC movement zone, which together form the visible surface.
- B. Description: Basis of Design: Schluter Systems L.P: "DILEX" profile with integrated trapezoid-perforated anchoring legs, connected by a 7/16 inch (11 mm) wide replaceable thermoplastic rubber movement zone, which together form the visible surface.

2.13 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; half-hard brass or white zinc alloy exposed-edge material as selected by Architect.
- 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.
- D. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 1. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Joint Sealant: Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, Shore A hardness not less than 35, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Uses T and NT.

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 the Work.
1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 2. Verify substrates comply with the flatness tolerances required by ANSI A108.01 and the following:
 - a. Tile with no edge larger than 15 inches; 1/4-inch in 10 feet.
 - b. Large Format Tile (15 inches or more on a side): 1/8 inch in 10 feet.
 3. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 4. 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.
 5. 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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, 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 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
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 in laundries.
 - c. Tile floors consisting of tiles 8 by 8 inches or larger.
 - d. Tile floors consisting of rib-backed tiles.
- B. 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.
- C. 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.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the joint widths the narrowest joint recommended in writing by tile manufacturer.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
- 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them and of equal or greater widths.
 - 2. Where tilework abuts restraining surfaces such as perimeter walls, curbs, columns, and ceilings.
 - 3. Where there is a change in substrate material.
 - 4. Interior Tilework: 20 to 25 feet in each direction.
 - 5. Above ground concrete substrates: 8 to 12 feet in each direction.
 - 6. Interior tilework exposed to direct sunlight: 8 to 12 feet in each direction.
 - 7. Interior tilework exposed to moisture: 8 to 12 feet in each direction.
- J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
- 1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thinset).
 - 2. Do not extend cleavage membrane waterproofing or crack isolation membrane under thresholds set in latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane waterproofing or crack isolation membrane with elastomeric sealant.

- K. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated, and at locations indicated.
- L. Floor Sealer: Apply floor sealer to cementitious grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.04 TILE BACKING PANEL INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.05 WATERPROOFING INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - 1. In all Toilet Rooms, Shower Rooms and Locker Rooms, cover entire floor with waterproofing/anti-fracture membrane and fabric reinforcement, extend waterproofing/anti-fracture membrane and fabric reinforcement up all walls a minimum of 4 inches. Waterproof all pipe and drain penetrations through membrane.
 - a. At showers, including changing area, install waterproofing/anti-fracture membrane and fabric reinforcement full height on walls under ceramic tile and lap over waterproof/anti-fracture membrane at base.
 - 1. Install fabric reinforcing according to manufacturer's instructions.
 - b. At all pipe and drain penetrations through waterproofing/anti-fracture membrane comply with the following:
 - 1. Install fabric reinforcing according to manufacturer's instructions.
 - 2. Extend waterproofing/anti-fracture membrane and fabric reinforcement into flange of floor drains.
 - 3. Extend waterproofing anti-fracture membrane and fabric reinforcement into pipe and conduit penetrations through waterproofing.
- B. Do not install tile over waterproofing/anti-fracture membrane until waterproofing/antifracture has cured and been tested to determine that it is watertight.

3.06 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- C. Fabric-Reinforced, Modified-Bituminous Sheet: Use where required to bridge existing cracks and to relocate crack control joints to coordinate with nearest tile grout joint: Install in accordance with manufacturer's instructions. Clean and prime concrete surface and allow primer to dry. Set self-adhering sheet in place, remove release sheet, and roll sheet to ensure full contact with substrate.

3.07 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove 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.

3.08 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
 - 1. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 09 30 00

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SCOPE:

The work covered by this section consists of furnishing all labor and materials for the complete installation of acoustical tile ceilings.

1.2 QUALITY ASSURANCE:

- A. In addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations published by the Ceilings and Interior Systems Contracting Association and the requirements of ASTM C636 (latest edition).

1.3 SUBMITTALS:

- A. Prior to installation, submit the following to the Architect for review:
 - 1. Submit manufacturer's project specifications and installation instructions for each type of acoustical panel and suspension system required, including certified laboratory test reports and other data necessary to show compliance with these specifications.
 - 2. Include manufacturer's recommendations for cleaning and refinishing acoustical panels, including precautions against materials and methods which may be detrimental to finishes and acoustical performances.
 - 3. Shop drawings, showing layout of each type of ceiling system in relation to surrounding structure, mechanical work (which shall include, but not be limited to, duct work and piping), lighting and electrical work, and any other pertinent fixtures and equipment. Drawings shall also show location of accessible panels. The reproduction of Architect's Drawings as the basis of these shop drawings will not be acceptable.
 - 4. Physical Samples: Furnish one sample of each type of ceiling board or tile and exposed grid in finish and pattern specified.

1.4 JOB CONDITIONS:

- A. Do not install interior acoustical panel ceilings until space enclosed and weatherproof, and until work above ceilings completed, and unit ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Ceiling Panels: 2 unopened boxes for each type indicated.
- B. This material shall not be available to the contractor for replacement goods within the building warranty period.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CEILING:

A. Subject to compliance of all specifications and requirements, provide acoustical ceiling as indicated here in this section and on the drawings, sheet A800, Acceptable Manufacturers:

1. Armstrong
2. USG
3. CertainTeed
4. Rulon International (basis of design) # Type 6

A. Ceiling panel:

1. # TYPE 1,
2'x2' acoustical ceiling tiles, square edge and 15/16" white t-bar suspension system.
 - a. Armstrong; Calla Square Tegular edge lay-in, (No. 2824) (White) 24" x 24" x 1" with 15/16"
 - b. USG Mars High-NRC Acoustical Panels: No. 88285 (White). 24" x 24" x 1.3".
 - c. CertainTeed; Symphony m High NRC – 1222BB-85-1, (White). 24" x 24" x 7/8".
2. # TYPE 2
 - a. Armstrong Clean Room VL, Unperforated No. 868, Square edge lay-in (White), 24" x 24" x 5/8" grid size
 - b. USG "Clean Room" with Clima Plus No. 56099, Square edge lay-in (White), 24" x 24" x 5/8" New Line
 - c. CertainTeed "Vinyl Shield A" No. 1102-CRF-1, (White), 24" x 24" x 5/8"
3. # TYPE 6: LINEAR CEILING PANELS
 - a. Rulon International: Endure wood grain, Linear Open Style:
 - 1). Provided in random lengths with tongue and groove ends or in fixed lengths. Standard lengths are 3 feet to 10 feet.
 - 2). Module Size: 4-1/2 inch (114 mm) module, having wood strips 3/4 inch (19 mm) thick by 3/4 inch (95 mm) wide, and a 3/4 inch (19 mm) reveal
 - 3). Trim and Border Treatment: Provide end caps or junction trims as indicated.
Wood Species: Endure Wood grain- 229 White Oak
 1. wood alternate, engineered polymer
 - 4). Suspension system – Carrier Suspension, #880 Endure Carrier
 - b. Or approved equal. Product must be approved in writing 5 days prior to bid date by the Architect.
 - c. Suggested manufacturer include
 1. 9 Wood – custom wood ceiling system
 2. Armstrong
 3. USG

B. Suspension System:

1. Exposed grid suspension system designed to accommodate ceiling board.
2. Suspension system shall conform to ASTM C635 (latest edition) and installation shall be in accordance with ASTM C636 (latest edition).
3. The suspension system shall support the ceiling panels with a maximum deflection of 1/360 of span. Exposed finish shall be white unless otherwise noted. The system shall include,

but not be limited to, the following:

- a. Material:
 - 1) Components shall be formed from commercial quality cold-rolled steel electrogalvanized.
 - b. Main Tee: Double web design; with cross tee holes at 6" o.c.; with hanger wire holes at 2" o.c.; with an integral reversible splice.
 - 1) 15/16" exposed face for non-rated assemblies.
 - 2) 15/16" exposed face Fire Guard for rated assemblies.
 - c. Cross Tee: Double web design; with web extended to form a positive interlock between cross tee webs through intersecting tee web holes; with the lower flange extended and offset to provide a flush level intersection.
 - d. Wall molding of a channel or angle shape with an exposed face.
- C. Suspension System Components: Main beams and cross tees in accordance with the requirements of the local governing building code, for seismic design category D, E and F in accordance with ASCE/SEI 7.
1. Structural Classification: ASTM C 635, Heavy Duty.
 2. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.
 3. Represented Systems: Prelude XL 15/16" as manufactured by Armstrong World Industries.
 - a. Attachment Devices: In accordance with the requirements of the local governing building code, for seismic design Category D, E and F.
 - b. Wire for Hangers and Ties: In accordance with the requirements of the local governing building code, for seismic design Category D, E and F.
 - c. Wall Moldings: In accordance with the requirements of the local governing building code, for seismic design Category D, E and F in accordance with ASCE/SEI 7.
 - 1) Nominal 7/8 inch x 7/8 inch hemmed, pre-finished angle molding (7800)

2.2 OTHER MATERIALS:

- A. All other materials, not specifically described but required for a complete and proper installation of the suspended acoustical ceiling, shall be as selected by the Contractor subject to the approval of the Architect.

PART 3 - EXECUTION

1.1 SURFACE CONDITIONS:

- A. Prior to all work of this Section, carefully inspect the installed work of all other Trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that suspended acoustical ceiling may be installed in accordance with the original design, all codes and regulations, the manufacturer's current recommendations and the approved submittals.
- C. In the event of discrepancy, immediately notify the Architect.
- D. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 COORDINATION WITH MECHANICAL AND ELECTRICAL:

- A. Coordinate with the requirements of other Trades. Use all means necessary to interface with adjacent materials.
- B. Where recessed lighting fixtures are installed in suspension system, consult with the fixture manufacturer prior to preparation of shop drawings so that the work of this Section shall be installed ready to receive the lighting fixtures. Modify the suspension system members adjacent to fixture locations as approved by the Architect and to the extent necessary to accommodate the fixtures.
- C. In the event lighting fixtures or air distribution or return air equipment other than those specified should be substituted under their respective Sections and/or Drawings and should the substituted fixtures require more extensive modifications, the Contractor shall make such required additional modifications and any additional cost shall be paid by the Contractor.
- D. Where wide or deep air conditioning ducts above suspended acoustical ceilings interfere with suspension hangers, provide independent framing below the duct work to support the ceiling as an obligation under this Section. Framing shall meet the approval of the Architect. Framing shall be supported from floor or roof structure above and shall in no case be attached to the duct work, piping or conduit.

3.3 SUSPENDED CEILING INSTALLATION:

- A. Comply with ASTM C 636 as applicable to acoustical panel ceilings, except to extent more stringent requirements indicated or required for compliance with governing regulations or fire resistance ratings.
- B. Suspend ceiling hangers from building structural members only, and only as indicated.
 - 1. Secure to structure, including intermediate framing members, by attaching to metal clips designed for type of member involved, or where possible, by looping and wire-tying directly to members.
- C. Space hangers not more than 4'-0" o.c. along each member supported directly from hangers, unless otherwise shown, and provide hanger not more than 6" from ends of each member.
- D. For the support of light fixtures, the fixture load shall be supported by supplemental hangers within 6" of each corner, or the fixture shall be supported separately.

3.4 MOLDINGS:

- A. Cope exposed flanges of intersecting members so that flange faces will be flush.
- B. Install edge moldings of type indicated at edges of each acoustical panel ceiling area, and at locations where edge of panel would otherwise be exposed after completion of work.
- C. Secure moldings to building construction by fastening through holes drilled in vertical leg. Space holes not more than 3" from each end and not more than 16" o.c. Draw-up fasteners for tight set against vertical surfaces.

- D. Miter corners of moldings accurately to provide hairline joints.
- E. Level moldings with ceiling suspension system, to level tolerance of 1/8" in 12'-0".

3.5 ACOUSTICAL PANEL INSTALLATION:

- A. Plan each layout to balance border widths at opposite edges of each ceiling area. Avoid use of less-than-half width units wherever possible. Comply with Architect's reflected ceiling plans to greatest extent possible.
- B. Install acoustical panels in coordination with suspension system, with edges concealed by support of suspension members.
- C. Scribe and cut panels for accurate fit at borders and at interruptions and penetrations by other work through ceilings.

3.6 CLEANING AND PROTECTION:

- A. Clean exposed surfaces of acoustical panels and of trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.
- B. Institute required protection for acoustical panel ceilings, including temperature and humidity limitations and dust control, so that work will be without damage and deterioration at time of substantial completion.

END OF SECTION 09 51 00

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.
 - 2. Homogeneous Composition of Polyvinyl Chloride (PVC) molding accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE – B-1 & B-2.

- A. Subject to compliance of all specifications in this section.
Acceptable manufacturers:
 - 1. Tarkett
 - 2. Mannington
 - 3. Allstate Rubber
- B. Product Standard: ASTM F1861, Type TP thermoplastic.
 - 1. Basis of Design: Roppe
 - 2. Style; see A700 Room Finish Schedule for location:
 - a. B-1 and - Cove base.
 - 1. 0.125 thick.
 - 2. 6" H
 - 3. Minimum length: 8'-0" or full coil length
 - 4. Inside corners: Score back for a tight to wall (no gap) install or a tight miter acceptable.
 - 5. Outside corners: Score back for a tight to wall (no gap) install. Snipped cove is acceptable if required.

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.
- D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. for each area, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 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 practical 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. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 8'-0" in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 8'-0" in length.
 - a. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.
 - 3. For treads installed as separate, equal-length units, install to produce a flush joint between units.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.

1. Apply three coat(s).
- C. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 65 19 – RESILIENT TILE FLOORINGS

PART 1 - GENERAL

1.01 SCOPE:

- A. Provide all of the labor, materials, equipment and services to furnish and install the resilient tile flooring and additionally named products.
- B. Section includes:
 - 1. Vinyl enhance tile
 - 2. Heavy duty resilient quartz composition floor tile.
 - 3. Rubber base

1.02 SUBMITTALS:

- A. Prior to installation, submit the following to the Architect for review:
 - 1. Manufacturer's literature fully describing each product and its proper installation for this Project.
 - 2. Physical sample (each product): All colors and patterns.
 - 3. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 4. Samples: Full-size units of each color and pattern of floor tile required.
 - 5. Maintenance data.

1.03 EXTRA MATERIALS:

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. Furnish no less than 5 boxes of each VET, SVT, 100' of extra rubber base (each color/profile).

PART 2 - PRODUCTS

2.01 VINYL ENHANCED TILE:

- A. Basis of design - Premium Tile: **VET-1**, 1/8" x 18" x 36", ASTM F1700 Class I – Monolithic homogenous solid vinyl tile Type A (smooth) surface.

Patcraft, Admix, colors and sizes reference the Interior Finish Legend on A700. Provide all colors for selection from manufacturer for substitutions.

- 1. Static Load/ ASTM F970: Modified – 2500 psi (lbs./sq. in.).
- 2. Residual Indentation/ ASTM F1914 – Passes.
- 3. Resistance to chemicals/ASTM 925 – Passes.
- 4. Radiant Flux/ASTM E 648 – Class 1.
- 5. Recommended adhesive Shaw 4100.
- 6. Indoor Air Quality – FloorScore Certified.
- 7. Installed with welding rods.
- 8. Apply manufacturer recommended wax coating after installation

- B. Acceptable manufacturers:
 - 1. Patcraft
 - 2. Tarkett
 - 3. Or an approved equal.

2.02 QUARTZ VINYL COMPOSITION FLOOR TILE – SVT-1 and SVT-2

- A. Basis of Design Product: Subject to compliance with requirements, provide Upofloor, Quartz composite tile made from PVC, plasticizer and stabilized compounded with quartz sand, calcium carbonate and pigments. Plasticizers are biobased phthalate free plasticizer. Surface treatment of urethane.
- B. Acceptable manufacturers:
 - 1. Kahrs
 - 2. Altro Rickett
 - 3. Upofloor or an approved equal.
- C. Basis of Design:
 - 1. Manufacturer: Kahrs, Upofloor, Style: Lines, SVT-1 - Colors: 8202 Conglomerate gray & SVT-2 - 8357 Blue
- D. Properties:
 - 1. Tile Standard: ASTM F1066.
 - 2. Fire resistance: Flammability exceed minimum for Class 1 rating per ASTM E648. Through-pattern tile.
 - 2. Wearing Surface: Smooth.
 - 3. Thickness: 0.08” inch (2.0 mm).
 - 4. Chemical Resistance: Quartz Tile is virtually unaffected by surface water and most chemicals which do not have a solvent action on vinyl. Certain chemicals can cause staining, and acids and dyes can affect the color, which should be selected accordingly.
 - 5. Flexibility: Meets requirements of ASTM F1066.
 - 6. Indentation Resistance: Meets indentation resistance requirements of ASTM F1066.
 - 7. Static Load Limit: Tile has been tested to 3000 psi (12410 Kpa) in accordance with ASTM F970.
 - 8. Size: 12 by 12 inches, 12 by 24 inches, 24 by 24 inches.
 - 9. Colors and Patterns: As selected by Architect from full range of industry colors.

2.03 INSTALLATION MATERIALS

- E. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- F. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- G. Adhesives, High Moisture: Water-resistant high-moisture type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 2. Use adhesives approved by tile flooring manufacturer for installation on floor slabs with up to 7 lb. of vapor pressure, relative humidity of up to 85 percent,
 - 3. Acceptable Products: Subject to requirements, provide adhesives acceptable to flooring manufacturer, which may include one of the following:

- a. Kahrs Upofloor, Mapei Ultrabond ECO V4SP, Mapei Ultrabond ECO VS 90 Plus, Ardex AF 145, Ardex AF 180.
- b. Altro, Ecofix 20- Hard set for heavy rolling loads.
- c. Approved equal.

H. Floor Polish: Do not polish. Refer to Division 01 Section "Progress and Final Cleaning."

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS:

- A. Prior to all work of this Section, carefully inspect the installed work of all other Trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that resilient tile flooring shall be installed in accordance with the original design and the manufacturer's recommendations.
- C. In the event of discrepancy, immediately notify the Architect.
- D. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 INSTALLATION:

- A. Install all products in strict accordance with the original design and the manufacturer's recommendations.
- B. In locations having higher moisture content or exposed to plumbing fixtures, a higher moisture resistant adhesive must be used. The adhesive should provide a minimum 10 lbs. moisture emission resistance and be necessary to include a ph blocker / primer.

3.03 CLEANING AND PROTECTION:

- A. Upon completion of the installation, immediately remove all surplus adhesive from adjacent surfaces. As soon as possible after installation, and in accordance with the timing recommended by the manufacturers, clean, seal, and wax all product surfaces according to manufacturer's recommendations
- B. Provide a non-staining paper pathway taped to the resilient flooring in direction of foot traffic throughout the Work.

END OF SECTION 09 65 19

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes all of the labor, material, equipment and services to furnish and install carpet tiles.

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Show the following:
 - 1. Existing flooring materials to be removed.
 - 2. Existing flooring materials to remain.
 - 3. Carpet tile type, color, and dye lot.
 - 4. Pattern of installation.
 - 5. Insets and borders.
 - 6. Edge, transition, and other accessory strips.
 - 7. Transition details to other flooring materials.
- C. Samples: For each color and texture required.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- long Samples.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- E. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- B. Mockups: Before installing carpet tile, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution, if requested by Owner or Architect.
 - 1. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.5 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.6 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
 - 1. Warranty Period: Lifetime commercial limited warranty from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet: For each type specified, boxes equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.
- B. This material shall not be available to the contractor for replacement goods within the building warranty period.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Products: Subject to compliance with requirements, provide one of the following:

1. CPT-1: Shaw Carpet
 - a. Color: vibrant mole 25485
 - b. Pattern: cross weave tile 5T526
 - c. Source: Shaw Contract
- B. Fiber Content: 100% NYLON
- C. Fiber Type: Ecosolution Q100 Nylon
- D. Pile Characteristic: Tufted, Insert construction – Multi-Level Pattern Loop
- E. Stitches: 9.0 per in
- F. Guage: 1/12 in.
- G. Total Weight: 0.277 in for finished carpet tile.
- H. Primary Backing/Backcoating: Manufacturer's standard composite materials - Synthetic
- I. Secondary Backing: Ecowax Tile
- J. Size: 18 by 36 inches
- K. Antimicrobial Treatment: Manufacturer's standard material, SSP Shaw Soil Protection
 1. VOC Limits: Provide carpet tile that complies with the following limits for VOC content when tested according to ASTM D 5116:
 - a. Total VOCs: 0.5 mg/sq. m x h.
 - b. 4-PC (4-Phenylcyclohexene): 0.05 mg/sq. m x h.
 - c. Formaldehyde: 0.05 mg/sq. m x h.
 - d. Styrene: 0.4 mg/sq. m x h.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
 1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D 5116:
 - a. Total VOCs: 10.00 mg/sq. m x h.
 - b. Formaldehyde: 0.05 mg/sq. m x h.
 - c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer, Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive
- C. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- D. Install pattern - Ashlar

3.2 CLEAN-UP AND PROTECTION

- A. Clean-up: Upon completion of the work, remove all waste, excess materials, tools and equipment from job site. Remove loose threads from carpeted surfaces. Remove adhesives from carpet and other surfaces, which are not scheduled to receive adhesive as they occur.
 - 1. Carefully and thoroughly vacuum clean carpeting with an upright bar type beater, vacuum cleaner.
 - 2. Usable pieces (approx. one sq. yd. and larger) of carpet not required to complete the work, shall be left on the job site and shall be placed in an orderly manner in an area designated by the Architect for the Owner's use.
- B. Repair: Prior to acceptance of installation, carpet, which is damaged, stained, discolored, torn, ripped or otherwise not acceptable, shall be repaired and replaced with new material in an approved manner recommended by the Architect.
- C. Protection: Protect installed carpeting from damages by other Contractors and be responsible for installing protective materials over traffic areas and if necessary closing off areas to traffic.
- D. Instruction: After the installation is completed, the carpet manufacturer and contractor shall provide representative to instruct the Owner's maintenance personnel in the care, cleaning and maintenance of the installed carpet.

END OF SECTION 09 68 13

SECTION 09 91 00 – PAINTING

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 surface preparation and field painting of the following:
 - 1. Exposed exterior items and surfaces.
 - 2. Exposed interior items and surfaces.
 - 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from a full range of 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 ironwork, and primed metal surfaces of mechanical and electrical equipment.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels. Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Related Sections include the following:
 - 1. Division 02 through 09.
 - 2. Divisions 22, 23 and 26: Painting of plumbing, mechanical and electrical work is specified in Divisions 22, 23 and 26, respectively.

1.3 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 5 and 20 when measured at a 60-degree meter.
 - 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 - 4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
 - 5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. Product Data: For each paint system specified. Include block fillers and primers.
 - 1. Material List: Provide 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: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use
- B. Samples for Initial Selection: Manufacturer's color fan deck showing the full range of colors available for each type of finish-coat material indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
- B. Comply with MPI standards for products and paint systems.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1.7 PROJECT CONDITIONS

- A. Apply paints per Paint Manufacturer's conditions and instructions.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
 - 1. Quantity: Furnish the Owner with an additional 5 percent, but not less than 1 gal. or more than 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products in the paint schedules.

- B. Manufacturers Names: The following manufacturers are referred to in the paint schedules by use of shortened versions of their names, which are shown in parentheses:
1. The Sherwin-Williams Co. (SW)
 2. PPG Paints (PPG)
 3. Benjamin Moore & Co. (Moore)

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and 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. 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: Provide color selections made by the Architect from the submitted approved manufacturer's complete set of available colors. Use 'Monochromatic Gray tinted primer' per manufacturer's recommendation for base coat of Deep and Ultra Deep colors.
- D. Areas to receive accent colors to be designated by Architect. Verify quantity of colors and location using the finish legend, finish plans, room schedule and elevations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 2. Start of painting will be construed as the 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 the Architect about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. Reinstall items when

painting is completed. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.

- B. **Cleaning:** Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning. Use appropriate cleaners or solvents recommended by the paint and coatings manufacturer.
 - 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 or tie coats over incompatible primers or remove and reprime.
 - 2. **Cementitious Materials:** Prepare concrete, concrete masonry block, 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. Form release agents on tilt up panels can be removed by recommended cleaners and pressurized water if recommended by manufacturer. Prepare surface per manufacturer's recommendations.
 - 3. **Wood:** Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - 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.
 - 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 the Steel Structures Painting Council's (SSPC) recommendations.
 - 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. These can be referred to as Passivator Coatings. Conduct a "Copper Sulfate" or other recommended method to see if Passivator Coatings are present. These **MUST** be removed to promote proper adhesion of primers and or finish coats.

- D. **Materials 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. Mechanically mix (drill mix) ALL dual component products as per manufacturers recommendations.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 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 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, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the 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 the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions sand between applications.
 2. Omit primer on metal surfaces that have been shop primed and touchup painted unless a FULL PRIME COAT is specified.
 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 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, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the 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 the type of material applied. Use brush of appropriate size for the surface or item being painted.
 2. Rollers: Use rollers of Polyester, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 3. Spray Equipment: Use airless spray equipment with Spray tip orifice size as recommended by the manufacturer for the material and texture required. ONLY use electric spray equipment indoors or in confined areas due to Carbon Monoxide and indoor air quality.

- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness (DFT) of the entire system as recommended by the manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
- F. Exposed mechanical items to be painted include, but are not limited to, the following:
 - 1. Pipe hangers and supports.
 - 2. Heat exchangers.
 - 3. Tanks that do not have factory-applied final finishes.
 - 4. Ductwork.
 - 5. Insulation.
 - 6. Motors and mechanical equipment
 - 7. Accessory items.
- G. Exposed electrical items to be painted include, but are not limited to, the following:
 - 1. Conduit, piping and fittings.
 - 2. Switchgear (Not already pre-finished).
 - 3. Panelboards (Not already pre-finished).
- H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled. Surface must be a minimum of 95% Pinhole free
- I. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the 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. Use gray tinted primer per manufacturer for base coat with saturated interior paint color selections.
- 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 or otherwise specified.
- 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.

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site. Do not dispose of paints and solvents in liquid or solid form on any on site trash containers or dumpsters.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 EXTERIOR PAINT SCHEDULE

- A. Concrete, Stucco, and Masonry (Other than Concrete Masonry Units): Provide the following finish systems over exterior concrete, stucco, and brick masonry surfaces:
 - 1. Flat Acrylic Finish: 2 finish coats over a primer.
 - a. Primer: Alkali-resistant, exterior, acrylic-latex primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
 - 1) SW: Loxon Concrete & Masonry Primer/Sealer, LX02W50.
 - 2) PPG: 4-603 PPG PermaCrete Alkali Resistant Primer Sealer.
 - 3) Benjamin Moore: Ultra Spec Hi-Build Masonry Primer/Sealer 609.
 - b. First and Second Coats: Flat, exterior, acrylic-emulsion paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.
 - 1) SW: A-100® Exterior Latex Flat, A6 Series
 - 2) PPG: 6-610XI Series Speedhide Flat Acrylic Latex Exterior Paint
 - 3) Benjamin Moore: Ultra Spec EXT Ext Flat HP N447.
- B. Concrete Masonry Units: (For non-intragal colored block) Provide the following finish systems over exterior concrete masonry units:
 - 1. Flat Acrylic Finish: 2 finish coats over a block filler.
 - a. Block Filler: High-performance, latex block filler applied at spreading rate recommended by the manufacturer to achieve a total dry mill thickness of not less than 7.0 mils DFT.
 - 1) SW: Pro Industrial Heavy Duty Block Filler, B42W150.
 - 2) PPG: 6-7 Speedhide Masonry Latex Hi-Fill Block Filler.
 - 3) Benjamin Moore: Ultra Spec Hi-Build Masonry Block Filler Flat (571)
 - b. First and Second Coats: Flat, exterior, acrylic-emulsion paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.
 - 1) SW: A-100 Exterior Latex Satin, A6 Series.
 - 2) PPG: 6-610XI Series Speedhide Flat Acrylic Latex Exterior.
 - 3) Benjamin Moore: Ultra Spec EXT Ext Satin HP N447.
- C. Exterior Gypsum Soffit Board: Provide the following finish systems over exterior gypsum soffit board:
 - 1. Flat Acrylic Finish: 2 finish coats over an exterior latex alkali-resistant primer, as recommended by the manufacturer.

- a. Primer: Exterior, alkyd- or alkali-resistant, acrylic-latex primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
 - 1) SW: Multi-Purpose Int/Ext Latex Primer, B51-450.
 - 2) PPG: 4-603 PPG PermaCrete Alkali Resistant Primer Sealer.
 - 3) Benjamin Moore: Ultra Spec Hi-Build Masonry Primer/Sealer 609.
 - b. First and Second Coats: Flat, exterior, acrylic-emulsion paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.
 - 1) SW: A-100® Exterior Latex Flat, A6 Series.
 - 2) PPG: 6-610XI Speedhide Flat Acrylic Latex Exterior.
 - 3) Benjamin Moore: Ultra Spec EXT Ext Flat HP N447.
- D. Wood Surfaces and Trim: Provide the following finish systems over smooth wood siding, plywood and other exterior wood surfaces and exterior trim: (Note: If there are existing wood surfaces that are to be painted that have an alkyd-based finish, prep surface per manufacturer's instructions before applying new finish.)
1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Exterior, alkyd or latex, wood primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
 - 1) SW: Exterior Oil-Based Wood Primer, Y24W8020.
 - 2) PPG: 17-921 Seal Grip Interior Exterior 100% Acrylic Universal Primer.
 - 3) Benjamin Moore: Benjamin Moore® Multi-Purpose Primer (067)
 - b. First and Second Coats: Semigloss, waterborne, exterior, acrylic enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.
 - 1) SW: A-100 Exterior Latex Satin, A82 Series
 - 2) PPG: 6-900XI Speedhide Exterior Semi-Gloss Acrylic Latex.
 - 3) Benjamin Moore Ultra Spec EXT Gloss N449.
- E. Wood Shakes and Rough Siding and Stained Wood: Provide the following finish systems over exterior wood shakes and rough wood siding and stained wood:
1. Flat Acrylic Finish: 2 coats of an acrylic-latex stain.
 - a. First and Second Coats: Solid-color, exterior, acrylic-latex, wood stain applied at spreading rate recommended by the manufacturer.
 - 1) SW: Superdeck Solid Color Acrylic Stain.
 - 2) PPG: FLD820 Flood Solid Color 100% Acrylic Stain.
 - 3) Benjamin Moore: ARBORCOAT® Waterborne Ultra Flat Solid Stain (610)
- F. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items unless a barrier or tie coat is required.
1. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a rust-inhibitive primer.
 - a. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils.
 - 1) SW: Kem Kromik Universal Primer B50WZ1
 - 2) PPG: 4160 MultiPrime Rust Inhibitive Metal Primers.
 - 3) Benjamin Moore: Corotech V131 Universal Metal Primer.

- b. First and Second Coats (DTM Acrylic Finish): Full-gloss, exterior High Performance Acrylic enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.0 mils.
 - 1) SW: Pro Industrial DTM Acrylic Gloss B66W100 Series.
 - 2) PPG: 4216 HP Pitt Tech Int/Ext DTM Acrylic Industrial Gloss Enamel.
 - 3) Benjamin Moore: Ultra Spec HP D.T.M. Acrylic Gloss (HP28).
- G. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces:
 - 1. Full-Gloss, Acrylic-Enamel Finish: 2 finish coats over a galvanized metal primer.
 - a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: Pro Industrial Pro-Cryl Universal Primer, B66-1300.
 - 2) PPG: 4020 Pitt Tech Plus WB Metal Primer- Finish
 - 3) Benjamin Moore: Ultra Spec Hp® Acrylic Metal Primer Hp04.
 - b. First and Second Coats (DTM Acrylic Finish): Full-gloss, exterior Acrylic enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.0 mils.
 - 1) SW: Pro Industrial DTM Acrylic Gloss B66-1050 Series.
 - 2) PPG: 4216 HP Pitt Tech Int/Ext DTM Acrylic Industrial Gloss Enamel.
 - 3) Benjamin Moore: Ultra Spec HP D.T.M. Acrylic Gloss (HP28).

3.7 INTERIOR PAINT SCHEDULE

- A. Concrete and Masonry and Concrete Masonry units. Provide the following paint systems over interior concrete and masonry surfaces: (Note: If there are existing surfaces that are to be painted that have an alkyd-based finish, prep surface per manufacturer's instructions before applying new finish.)
 - 1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer or block filler.
 - a. Primer (no-masonry units): Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.0 mils.
 - 1) SW: Loxon Concrete & Masonry Primer/Sealer, LX02W50.
 - 2) PPG: 4-603 PPG Perma Crete Acrylic Latex Alkali Resistant Primer.
 - 3) Benjamin Moore: Ultra Spec Acrylic Masonry Primer/Sealer 608.
 - b. Block Filler (for masonry units only): High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 7.0 mils.
 - 1) SW: Pro Industrial Heavy Duty Block Filler, B42W150.
 - 2) PPG: 6-7 Speedhide Masonry Latex Hi-Fill Block Filler.
 - 3) Benjamin Moore: Ultra Spec Hi-Build Masonry Block Filler Flat (571)
 - c. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.
 - 1) SW: ProMar 200 Zero VOC Semi-Gloss, B31-2600 Series.
 - 2) PPG: 6-4510XI Speedhide Zero VOC Latex Semi Gloss.
 - 3) Benjamin Moore: Ultra Spec 500 Semi-Gloss (N539)

2. Two Component, Epoxy Coating with Gloss Finish: 2 finish coats over a block filler.
 - a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 7.0 mils.
 - 1) SW: Pro Industrial Heavy Duty Block Filler, B42W150.
 - 2) PPG: 6-7 Speedhide Masonry Latex Hi-Fill Block Filler.
 - 3) Benjamin Moore: Ultra Spec Hi-Build Masonry Block Filler or Corotech V155 100% Solids Epoxy Pre-Primer Semi-Gloss
 - b. First and Second Coats: Gloss, epoxy emulsion.
 - 1) SW: Waterbased Catalyzed Epoxy B70-200/B60V15.
 - 2) PPG: 98-1 Aquapon Waterbased Gloss Epoxy Coating
 - 3) Benjamin Moore: Corotech Waterborne Acrylic Epoxy Gloss (V450).
 3. Single Component Pre- Catalyzed Epoxy Gloss Coating: 2 finish coats over a block filler.
 - c. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 7.0 mils.
 1. SW: Pro Industrial Heavy Duty Block Filler B42W150
 2. PPG: 6-7 Speedhide Masonry Latex Hi-Fill Block Filler.
 3. Benjamin Moore: Ultra Spec Hi-Build Masonry Block Filler Flat (571)
 - d. First & Second Coats: Pre-Catalyzed WB Epoxy Coating applied at a spread rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.0mils.
 1. SW: Pro Industrial Pre-Catalyzed WB Epoxy Semi-Gloss, K46 Series.
 2. PPG: 16-551 Pitt Glaze Pre- Catalyzed WB Gloss Epoxy Coating
 3. Benjamin Moore: V341 Corotech Pre- Catalyzed WB Semi- Gloss Epoxy
- B. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
1. Acrylic-Enamel Finish:(for walls) 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: ProMar 200 Zero VOC Primer, B28W2600.
 - 2) PPG: 6-4900XI Speedhide Zero VOC Interior Latex Primer Sealer.
 - 3) Benjamin Moore: Ultra Spec 500 Primer (534).
 - b. First and Second Coats: Low-Sheen (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
 - 1) SW: ProMar 200 Zero VOC Eg-Shel, B20-2600 Series.
 - 2) PPG: 6-4310XI Speedhide Zero "0" VOC Latex Eggshell.
 - 3) Benjamin Moore: Ultra Spec 500 Eggshell (T538).
 2. Flat Acrylic Finish:(for ceilings and soffits) 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
 - 1) SW: ProMar 200 Zero VOC Primer, B28W2600.
 - 2) PPG: 6-4900XI Speedhide Zero VOC Latex Primer Sealer.
 - 3) Benjamin Moore: Ultra Spec 500 Primer (534).

- b. First and Second Coats: Low-Sheen (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
 - 1) SW: ProMar 200 Zero VOC Flat, B30-2600 Series.
 - 2) PPG: 6-4110XI Speedhide Zero VOC Latex Flat Enamel.
 - 3) Benjamin Moore: Ultra Spec 500 Interior Eggshell Finish (T538).
 3. Two Component Epoxy Semigloss Coating: 2 finish coats over a block filler or primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: ProMar 200 Zero VOC Primer, B28W2600.
 - 2) PPG: 6-4900XI Speedhide Zero VOC Latex Primer Sealer.
 - 3) Moore: Ultra Spec 500 Primer (534).
 - b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.
 - 1) SW: Waterbased Catalyzed Epoxy Semi-Gloss B70/B60V25.
 - 2) PPG: 98-1 Aquapon Waterbased Semi- Gloss Epoxy Coating
 - 3) Benjamin Moore: Corotech Waterborne Acrylic Epoxy Gloss (V450).
 4. Single Component Pre-Catalyzed Epoxy Coating: 2 finish coats over a Gypsum Board primer.
 - a. Primer: Latex-based, interior primer applied at a spread rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.0 mils.
 - 1) SW: ProMar 200 Zero VOC Primer, B28W2600.
 - 2) PPG: 6-4900XI Speedhide Zero VOC Latex Primer Sealer.
 - 3) Benjamin Moore: Ultra Spec 500 Primer (534).
 - b. First and Second Coats: Pre-Catalyzed Epoxy Coating applied at a spread rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.0 mils.
 - 1) SW: Pro Industrial Pre-Catalyzed WB Epoxy Coating K46
 - 2) PPG: 16-551 Pitt-Tech Pre-Catalyzed WB Epoxy Coating
 - 3) Benjamin Moore: Corotech Pre-Catalyzed WB Epoxy Coating V341
- C. Woodwork and Hardboard: Provide the following paint finish systems over new, interior wood surfaces:
1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a wood undercoater.
 - a. Undercoat: Acrylic-latex-based, interior wood undercoater, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: ProMar 200 Zero VOC Primer, B28W2600.
 - 2) PPG: 6-4900XI Speedhide Zero VOC Latex Primer Sealer.
 - 3) Benjamin Moore: Ultra Spec 500 Primer (534).
 - b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.
 - 1) SW: ProMar 200 Zero VOC Semi-Gloss, B31-2600 Series.
 - 2) PPG: 6-4510XI Speedhide Zero VOC Latex Semi-Gloss.
 - 3) Benjamin Moore: Ultra Spec 500 Semi-Gloss (N539).

2. Semigloss, Waterbased-Alkyd-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Odorless Alkyd or latex-based, interior enamel undercoater applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: ProBlock Interior Oil-Based Primer, B79W8810.
 - 2) PPG: 17-921 Seal Grip Acrylic Universal Primer.
 - 3) Benjamin Moore: Fresh Start Undercoater & Primer/Sealer (032).
 - b. First and Second Coats: Odorless, semigloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.
 - 1) SW: ProMar 200 Acrylic-Alkyd Semi-Gloss, B34W8200.
 - 2) PPG: 6-1510 Speedhide Interior Exterior WB Alkyd Semi Gloss.
 - 3) Benjamin Moore: Advance WB Alkyd Semi-Gloss 793.
- D. Ferrous Metal: Provide the following finish systems over ferrous metal:
 1. Semigloss, Acrylic -Enamel Finish: One finish coat over an enamel undercoater and a primer.
 - a. Primer: Quick-drying, rust-inhibitive, Acrylic or Waterbased epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 -4.0 mils.
 - 1) SW: Pro Industrial Pro-Cryl Universal Primer, B66-1300.
 - 2) PPG: 4020PF Pitt Tech WB Metal Primer- Finish
 - 3) Benjamin Moore: Ultra Spec Hp® Acrylic Metal Primer HP04.
 - b. Finish Coat: Odorless, semigloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.4 mils.
 - 1) SW: ProMar 200 Acrylic-Alkyd Semi-Gloss, B34W8200.
 - 2) PPG: 6-1510 Speedhide Interior Exterior WB Alkyd Semi Gloss.
 - 3) Benjamin Moore: Ultra Spec 500 Semi-Gloss (T546).
- E. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal:
 1. Eg-Shel or Satin, Acrylic-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: Pro Industrial Pro-Cryl Universal Primer, B66-1300.
 - 2) PPG: 90-712 Series Pitt-Tech Acrylic Primer/Finish.
 - 3) Benjamin Moore: Ultra Spec Hp® Acrylic Metal Primer HP04.
 - b. First and Second Coats: Low- Sheen (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
 - 1) SW: ProMar 200 Zero VOC Eg-Shel, B20-2600 Series.
 - 2) PPG: 6-4310XI Speedhide Zero “0” VOC Latex Eggshell.
 - 3) Benjamin Moore: Ultra Spec 500 Eggshell (N538).
- F. Exposed Metal Structure: Metal decking, structural beams, braces, columns, bar joists and miscellaneous ductwork.: Provide the following finish systems over these substrates. **NOTE: Check for Passivator Coatings on substrates. Conduct a Copper Sulfate or recommended test. If protective coating or film is present it must be removed entirely prior to application of primers and or finish coats. Consult paint manufacturer for recommendations.**

1. Flat, Eg-Shell or Semi-Gloss Dryfall Coating: 1-2 finish coats over a primer.
 - a. Primer: IF NEEDED : Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) SW: Pro Industrial Pro-Cryl Universal Primer, B66-1300.
 - 2) PPG: 90-712 Series Pitt-Tech Acrylic Primer/Finish.
 - 3) Moore: Ultra Spec Hp Acrylic Metal Primer Hp04
 - b. First and Second Coats: Flat, Eggshell or Semi-Gloss interior Latex Dyfall Coatings applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
 - 1) SW: Pro Industrial Waterborne Dryfall B42 Series
 - 2) PPG: 6-724xi Super Tech Waterborne Dryfall Coatings
 - 3) Benjamin Moore: Latex Dryfall - Flat 395

END OF SECTION 09 91 00

SECTION 09 98 60 - SANITARY WALL FINISH (Interior FRP)

PART 1 - GENERAL

1.01 SCOPE:

- A. This section describes the requirements for furnishing and installing fiberglass reinforced plastic panels according to manufacturer's recommendations.

1.02 SUBMITTALS:

- A. Submit in accordance with Division 01.
 - 1. Two samples of each type of panel, each type of trim and fastener.
 - 2. Shop Drawings: Indicate the location and dimension of joints and fastener attachments.
 - 3. Installation Guide.

1.03 QUALITY ASSURANCE:

- A. Provide panels and molding only from the manufacturer specified to ensure warranty and color harmonization of accessories.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Delivery of Materials: Package sheets on skids or pallets for shipment to project site.
- B. Storage of Materials: Store panels in a dry place at the project site.
- C. Handling: Remove foreign matter from face of panel by use of a soft bristle brush, avoiding abrasive action.

1.05 PROJECT CONDITIONS:

- A. Installation shall not begin until building is enclosed, permanent heating and cooling equipment in operation, and residual moisture from plaster, concrete or terrazzo work has dissipated.
- B. During installation and for not less than 48 hours before, maintain an ambient temperature and relative humidity within limits required by type of adhesive used and recommendation of adhesive manufacturer.
- C. Provide ventilation to disperse fumes during application of adhesive as recommended by the adhesive manufacturer.

PART 2 – PRODUCTS

2.01 MATERIALS:

- A. Class A © Interior Finish. Wall panels shall be Glasbord “FX” with Surfaseal, (fiberglass reinforced plastic panels / FRP). Manufactured by Crane Composites Inc., Channahon, Illinois 60410. PH: 1-800-435-0080, fax: 1-815-467-8666, website: cranecomposites.com. (Acceptable manufacturers: Marlite – Standard FRP; MDC Interior Solutions FRP Panels).

Color to be White 85. Finish to be Pebbled Embossed texture. Panel thickness shall be nominal .09" (2.3mm) for Glasbord for use as general purpose wall application. Panel size to be 4'-0" x 8'-0". Approved Equal Manufacturers per Division 01.

1. Independent laboratory ASTM E-84 testing.
2. Flame Spread of 200 or lower, Smoke Developed of 450 or lower per ASTM E-84 latest version.
3. Barcol Hardness: 40 (scratch resistance) ASTM D-2583.
4. Panels will exhibit no more than a 0.038% weight loss after a 25-cycle Taber Abrasion Test.
5. Impact Strength ASTM 5420: 45.0 in/lbs showing no visible damage on finish side.
6. Meets USDA/FSIS Guidelines.
7. A means of frontside identification and confirmation of meeting Class A © interior finish requirements after installation and while in service without labels.

- B. Moldings:

1. Standard vinyl/PVC (polyvinylchloride) moldings shall be: 85 White.

- C. Sealant: Joints sealed with a high quality clear silicone sealant in food preparation, storage, or process areas, areas of high moisture, and in areas where steam cleaning occurs.
- D. Rivets: Optional. Specify rivets in harmonizing colors (by color name and number) in areas where there are wide changes in temperature or humidity, where the substrate is unusually uneven, and in all low temperature or cold storage applications. Refer to Installation Guide #6211 for rivet pattern and installation instructions.

END OF SECTION 09 98 60

Division 10 - Specialties

SECTION 10 11 00 – VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.01 SCOPE:

- A. Provide all labor, materials, equipment and services required to furnish and install the markerboards

1.02 SUBMITTALS:

- A. Prior to fabrication, submit to the Architect for review the following:
 - 1. Complete and fully descriptive manufacturer's literature which shall include the manufacturer's currently recommended installation methods.
 - 2. Shop drawings showing complete dimensions, details, and layouts.
 - 3. Physical sample of all colors available for the Architect's selection.
- B. As a condition precedent to the final acceptance, furnish a manufacturer's certificate stating that the work installed under this Section has been fabricated and installed in all respects in compliance with the Contract Documents.

PART 2 - PRODUCTS

2.01 MARKERBOARD:

- A. Whiteboard Wet Markerboard:
Porcelain Steel Whiteboard with Deluxe Aluminum Trim as manufactured by
 - 1. Claridge Products and Equipment, Inc.
 - 2. Other acceptable manufacturers subject to compliance with this specification and the specifications of the product listed above are:
 - 2. MooreCo/Vanerum North America
 - 3. Marsh Industries, Inc
 - 4. Platinum Visual Systems Inc.
 - 5. ASI Visual Display Products
- B. Sizes: Standard height 4'-0" high unless otherwise noted. See drawings for widths or if not indicated 8' long.
- C. Trim: Aluminum with marker tray and tack strip at top.
- D. Color Finish as selected by Architect
- E. Coordinate exact locations with Owner and Architect.

2.04 OTHER MATERIALS:

- A. All other materials, not specifically described but required for a complete and proper installation of the boards and the tackboard, shall be as selected by the Contractor subject to the approval of the Architect.

PART 3 – EXECUTION

3.01 GENERAL:

- A. Materials shall be installed in accordance with the Contract Documents, approved shop drawings, and manufacturer's instructions. It is the intention of this Specification to provide materials manufactured and installed in such a manner as to be rigidly anchored to assure a permanent installation.

3.02 INSTALLATION:

- A. Install all the chalkboards and tackboards where indicated on the Drawings and as indicated on the approved submittals, anchoring all components firmly in place for long life under hard use and in complete accordance with the manufacturer's recommendations.

3.03 INSPECTION AND ADJUSTMENT:

- A. Upon completion of the installation, and as a condition of its acceptance, visually inspect the entire work of this Section, adjust all components for proper operation and straight alignment, and touch-up all scratches and abrasions to be completely invisible.

END OF SECTION 10 11 00

SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section includes the following types of signs:
 - 1. Panel and Code Required Signs
 - 2. Door Identification Tags
 - 3. Interior pin mounted and plaques
 - 4. Exterior dimensional characters

1.02 SUBMITTALS:

- A. General:
 - 1. Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data:
 - 1. Product data for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- C. Samples: Provide the following samples of each sign component for initial selection of color, pattern and surface texture as required and for verification of compliance with requirements indicated.
- D. Color Charts: Manufacturer's color charts consisting of actual sections of material including the full range of colors available for each material required.
- E. Samples of Interior Plaques: Two actual-sized samples of interior plaques showing compliance with requirements.

1.03 QUALITY ASSURANCE:

- A. Sign Fabricator Qualifications: Firm experienced in producing signs similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.
- B. Single-Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.
- C. Design Concept: The drawings indicate sizes, profiles, and dimensional requirements of signs and are based on the specific types and models indicated. Sign units by other manufacturers may be considered provided deviations in dimensions and profiles do not change the design concept as judged by the Architect. The burden of proof of equality is on the proposer.

1.04 WARRANTY:

- A. General Warranty: The warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents, Uniform Commercial Code regulations or applicable state statutes of limitations. This

warranty shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Manufacturers of Sawn Letters:
 - a. Modulex Americas
 - b. Andco Industries Corp.
 - c. ASI Sign Systems, Inc.
 - d. Gemini, Inc.
 - e. Leeds Architectural Letters, Inc.
 - f. Matthews International
 - g. Spanjer Brothers, Inc.
 - h. Vomar Products, Inc.
 - i. 2/90 Signage Systems
 - 2. Manufacturers of Interior Plaques:
 - a. Modulex Americas
 - b. Andco Industries Corp.
 - c. ASI Sign Systems, Inc.
 - d. Leeds Architectural Letters, Inc.
 - e. Matthews International
 - f. 2/90 Signage Systems

2.1 MATERIALS

- A. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thick nesses indicated, with a minimal flexural strength of 16,000psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 deg F.
- B. Aluminum Sheet: Provide aluminum sheet of alloy and temper recommended by the sign manufacturer for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 209 for 5005-H15.
- C. Fasteners: Use tamper resistant concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.
- D. Anchors and Inserts: Use nonferrous metal or hot-dipped 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 masonry work.
- E. Colored Coatings for Acrylic Plastic Sheet: Use colored coatings, including inks and paints for copy and background colors, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for the application intended.
 - a. Opaque Sheet: Colored, in colors as selected from manufacturer's full range.
- F. Brass Castings: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
- G. Brass, Yellow, Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000.

2.2 FINISHES:

- A. Baked-Enamel Finish: AA-M4xC12C42R1x (Mechanical Finish: Manufacturer's standard, other nondirectional textured; Chemical Finish: Chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below).

Apply baked enamel in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting.

1. Organic Coating: Thermosetting-modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with a minimum dry film thickness of 1.5 mils, medium gloss.
 - a. Color: Selected from manufacturer's standard colors

2.3 FABRICATION – PANEL SIGNS

- A. Unframed Panel Signs: Fabricate with smooth edges mechanically finished.
 1. Edge Condition: Beveled.
 2. Edge Color for Plastic Laminate: Same as background.
- B. Raised Copy: Machine-cut copy characters from matte-finished opaque acrylic sheet and chemically weld onto acrylic sheet forming sign panel face. Produce precisely formed characters with square cut edges free from burrs and cut marks.
- C. Aluminum anodized, bead-blasted return, #514 aluminum alloy.
- D. Sign panels shall be 1/8-inch thick acrylic plastic. Mount sign panels with concealed fasteners.
- E. Sign panels shall be sized as indicated on Drawings.
- F. Provide signs with minimum 1/32-inch raised text, upper case, with Grade 2 braille, and at required locations provide universal symbols directly above text.

2.4 INTERIOR DIMENSIONAL CHARACTERS

- A. Provide individual pin mounted letters and plaques
- B. See drawings for locations and dimensions. The Font will be determined by the Architect.
- C. Characters shall be 3/8" thick flat cut out Aluminum.
- D. Characters shall be protected with manufacturers protective lacquer coating.
- E. Install characters with concealed pin mounting per manufacturer's recommendations for substrate being installed on.

2.5 EXTERIOR DIMENSIONAL CHARACTERS

- A. Provide individual plate letters with metal studs for concealed flush mounting to walls and bottom back angle bracket for letters on the curtain wall system.
- B. See drawings for locations and dimensions. The Font will be determined by the Architect.
- C. Characters shall be .375" Stainless Steel conforming to Alloy 304 and Aluminum.
- D. Characters to have satin brushed finish.

2.6 APPLIED VINYL WINDOW SIGNAGE

- A. See drawings for locations and dimensions.
- B. Translucent cast vinyl .09 mm applied glass text and signage as indicated on the drawings. Pattern/style to be selected by Architect as "3M - Milky Milky (San Marino) SH2MAMM" or as selected from the manufacturer's full range.

- C. Adhesive: Solvent acrylic; pressure-sensitive tape. 17N/25 mm. FTM 1:180 degree peel, substrate: glass; cond: 24 h 23 degree C/50%RH.

PART 3- EXECUTION

3.1 INSTALLATION

- A. General: Locate signs where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
 - 1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.
- B. Interior Plaques: Attach panel signs to wall surfaces using the methods indicated below:
 - 1. Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces.
 - 2. Concealed Mounting: Mount the plaques by inserting threaded studs into tapped lugs on the back of the plaque. Set in predrilled holes filled with quick-setting cement.
 - 3. Cement Mounting: Mount plaques using exposed fasteners with rosettes attached through the face of the plaque into the wall surface.

3.02 CLEANING AND PROTECTION:

- A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

3.2 SCHEDULE

- A. Restroom signage:
 - 1. Exact text to be determined by Owner. Refer to drawings.
- B. General Room Signage:
 - 1. Exact text to be determined by Owner. Refer to drawings.
- C. Exit Signage:
 - 1. Provide raised letter and Braille exit signs at all required exit doors. Coordinate locations with local Building Inspector. Refer to drawings.
- D. Pin Mounted Signage:
 - 1. Exact text to be determined by Owner. Refer to drawings for sizes and locations.
- E. Cast Letters:
 - 1. Exact text to be determined by Owner. Refer to drawings for sizes and locations.

END OF SECTION 10 14 00

SECTION 10 21 13 - TOILET COMPARTMENTS – SOLID PLASTIC

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes toilet compartments as follows:
Type:(HDPE) High Density Polyethylene.
Compartment Style: Overhead braced and floor anchored.
- B. Related Sections include the following:
Section 10 28 13 “Toilet Accessories” for toilet paper holders, grab bars, purse shelves, and similar accessories.
- C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUBMITTALS:

- A. Product Data: For each type and style of toilet compartments specified. Include details of construction relative to materials, dimensions of individual components, fabrication, and installation. Include details of anchors, hardware, and fastenings.
- B. Shop Drawings: For fabrication and installation of toilet compartment assemblies. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of reinforcement and cutouts for compartment-mounted toilet accessories.
- C. Samples for Verification:
 - 1. Submit 6” square samples of each color and finish on same substrate used in work, for color verification after selections have been made.
 - 2. Submit one (1) sample of the following:
 - a. Hardware (Complete)
 - b. Stainless Steel Mounting Bracket
 - c. Stainless Steel Hinges
- D. Maintenance Instructions: Provide manufacturer’s printed instructions for Maintenance of installed Work.
- E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.03 PROJECT CONDITIONS:

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.04 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Product Certificates: For each type of toilet compartment by manufacturer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data. For toilet compartments to include maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [25] [75] [200] or less.
2. Smoke-Developed Index: 450 or less.

2. Regulatory Requirements: Comply with applicable provisions in the U.S. Department of Justice "2010 ADA Standards for Accessible Design" and ICC A117.1 for toilet compartments designated as accessible.

2.02 SOLID-PLASTIC TOILET COMPARTMENTS:

- A. Provide Basis of Design: TP-1, Scranton, ASI Global partition, Texture: Hammered, Color: as listed on A700 – Finish Legend.
- B. Floor & ceiling anchored.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ASI Global Partitions (Eastanollee, GA 30538)
 2. General Partitions (Erie, PA 16505-4243)
 3. Scranton Products, Hiney Hiders (Scranton, PA 18505)
- D. Provide a 25-year product warranty.

2.03 MATERIALS:

- A. General: Provide material which has been selected for surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections on finished units are not acceptable.
- B. Material shall be Solid High Density Polyethylene (HDPE) and shall have homogenous color throughout entire thickness. HDPE shall be waterproof, non-absorbent and shall have a self-lubricating surface to resist marks from pens, pencils and other writing instruments. Doors

and Panels shall have a finished height of 55.0". All edges shall have a .250" radius.

1. Doors – Minimum 1.00" (25 mm) Finished Thickness
 2. Divider Panels – Minimum 1.00" (25 mm) Finished Thickness
 3. Pilasters – Minimum 1.00" (25 mm) Finished Thickness
- C. Pilaster Shoes: Select one of the following:
1. ASTM A 167, Type 304 Stainless Steel, minimum 3" high, 18 gauge, #4 finished, attached with Stainless Steel Through Bolts.
- D. Pilaster Shoes: Select one of the following:
1. ASTM A 167, Type 304 Stainless Steel, minimum 3" high, 18 gauge, #4 finished, attached with Stainless Steel Through Bolts.
- E. Brackets: All Brackets shall be made of Cast-Stainless Steel. Inside of opening of Bracket shall be 1.00" for panels and pilasters. All holes for mounting to wall and panel/pilaster shall be pre-drilled. Each Bracket is to have a minimum wall thickness of .125". The stock number shall be molded into the back of each bracket for ease in identification. Each Bracket is to be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer. Urinal screen brackets to be continuous type.
- F. Hinge: 11 Gauge Stainless Steel Hinge. Hinge shall be made of Type 302/304 Stainless Steel and shall have a Satin finish. Hinge shall be gravity type for self-closing action and shall be fully adjustable up to 360 degrees. Pivot pin shall be made of Type 302/304 Stainless Steel. Hinges shall provide emergency access by lifting the door. Hinges shall be pre-drilled for mounting to door and pilaster with Stainless Steel Through-Bolts. Each Hinge is to be packaged in a separate carton, and is to be labeled by stock number, manufacturer, and left or right hand.
- G. Strike and Keeper: Heavy Duty Stainless Steel with a Satin finish. The Strike and Keeper shall be 2.50" high, with the mounting holes at 1.50" O.C., and the wall thickness shall be a minimum of .125". The Strike and Keeper shall have an integral rubber bumper door stop. The stock number shall be molded into the back of the Strike and Keeper for ease in identification. Each Strike and Keeper shall be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer. Furnish one per door.
- H. Slide Latch: Heavy Duty Stainless Steel with a Satin finish. The Slide Latch shall be surface mounted. The slide bar shall be .150" thick, 1.020" wide and 3.720" long. Latch shall have an internal Stainless Steel buffering spring to prevent damage when door is inadvertently slammed against the Latch. Mounting holes are to be spaced at 3.50" O.C. Latch knob is to be riveted to the slide bar and then welded to insure that the knob will not come off. The stock number is to molded into the back of the Slide Latch for ease in identification. Each Slide Latch shall be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer. Furnish one per door.
- I. Coat Hook: Coat Hook and Bumper shall be 2.340" high, 1.230" wide and shall protrude out from the door 3.05". The hook portion shall have a finished diameter of .250". The stock number shall be molded into the back of the Coat Hook and Bumper for ease in identification. Each Coat Hook and Bumper shall be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer. Furnish one per door.
- J. Door Stop: Door Stop shall have a 2.125" base diameter and shall protrude 1.80" from the wall. The bumper at the end of the Door Stop shall be .250" thick. The diameter of the shaft

shall be .6875". The stock number shall be molded into the back of the Door Stop for ease in identification. Each Door Stop shall be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer. Furnish one for each Disabled Accessible door.

- K. Pull Handle: Heavy Duty Stainless Steel with a Satin finish. Plated Zamac Door Pulls are unacceptable. Pull Handle shall protrude from the face of the door .940" and shall be 4.735" long. The Pull Handle shall have mounting holes drilled and tapped for 10/24 threads at 3.50" O.C. The Pull Handle shall be .655" wide and shall be mounted back to back with the Slide Latch. The stock number shall be molded into the back of the Pull Handle for ease in identification. Each Pull Handle shall be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer. Furnish one for each Disabled Accessible door.
- L. Overhead Bracing (Headrail): Continuous Heavy Duty Extruded 6063-T5 Aluminum Headrail with Anti-Grip profile. Headrail shall have integral reinforcing channel and curtain track. Headrail shall have a Satin Anodized finish. Provide Headrail Corner Brackets, Wall Brackets, and Headrail End Caps as required. The Headrail and Headrail Brackets shall have a minimum wall height of 2". The minimum wall thickness of the Headrail and Headrail Brackets shall be .125". Each Headrail Bracket is to be packaged in a separate poly bag, and is to be labeled by stock number and manufacturer.
- M. Anchorages and Fasteners: All Fasteners shall be Stainless Steel with theft proof heads, Through-Bolted unless noted otherwise. No chrome plated steel or brass will be acceptable

2.04 FABRICATION:

- A. General: Provide standard doors, panels, screens and pilasters fabricated for partition system, complete with all accessories and hardware listed above and as required for installation of fully functional system, unless otherwise noted. Provide units with cutouts and drilled holes to receive partition-mounted hardware, accessories, and grab bars as indicated.
- B. Overhead-Braced and Floor-Anchored Partitions:
 - 1. Make provision for setting and securing continuous Extruded Aluminum Anti-Grip Headrail at top of each pilaster.
 - 2. Furnish Stainless Steel Shoe at each pilaster to conceal supports and leveling mechanism.
- C. Doors: Unless otherwise indicated, provide 24" (610 mm) wide in-swinging doors for standard Toilet Partitions and 36" (914 mm) wide out-swinging doors with a minimum 32" (813 mm) wide clear opening for Partitions indicated to be Handicapped Accessible.
- D. Floor Anchored Privacy Screens: Furnish Privacy Screens consisting of a pilaster and a panel of the same construction and finish as the Toilet Partitions. Furnish in accordance with the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. General: Comply with manufacturer's written installation instructions. Install Partitions rigid, straight, plumb, and level. Provide clearances of not more than .50" (13 mm) between pilasters

and panels, and not more than 1.0" (25 mm) between panels and walls. No evidence of drilling, cutting and patching shall be visible in finished work.

- B. Overhead-Braced and Floor-Anchored Partitions: Secure pilasters to floor and level, plumb, and tighten. Secure continuous Headrail to each pilaster with not less than two (2) Through-Bolted Stainless Steel fasteners. Hang doors and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Screens: Attach with anchoring devices according to manufacturer's written instructions and to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.02 ADJUSTING AND CLEANING:

- A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation.
- B. Provide final protection and maintain conditions that ensure Toilet Partitions and Screens are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 10 21 13

SECTION 10 26 13 – CORNER GUARDS

PART 1- GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Corner Guards.
- B. See Division 06 Section "General Carpentry" for blocking required for installing fasteners.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product data and detailed specifications for each system component and installation accessory required, including installation methods for each type of substrate.
- C. Shop drawings showing locations, extent and installation details of corner guards. Show methods of attachment to adjoining construction.
- D. Samples for verification purposes: Submit the following samples, as proposed for this work, for verification of guard.
 - 1. 12" long sample of each model specified.
 - 2. Physical Color sample showing full range of manufacturer's colors and finish options.
- E. Product test reports from a qualified independent testing laboratory showing compliance of each component with requirements indicated.
- F. Maintenance data for wall protection system components for inclusion in the operating and maintenance manuals specified in Division 1.
- G. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. "Laboratory Test Reports" Subparagraph below applies to LEED 2009 for Schools, LEED v4, IgCC, ASHRAE 189.1, and Green Globes. Coordinate with requirements for adhesives.
 - 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 4. Submit all GreenGuard Gold, Recycled content, VOC Certificate of Compliance, EPD and/or HPD certificates and information for all materials in this section.
 - 5. Reference section 018113 for guidelines for LEED v4 BD+C submittals.

1.3 QUALITY ASSURANCE

- A. Installer qualifications: Engage an installer who has no less than 3 years' experience in installation of systems similar in complexity to those required for this project.
- B. Manufacturer's qualifications: Not less than 5 years' experience in the production of specified products and a record of successful in-service performance
- C. Code compliance: Assemblies should conform to all applicable codes including IBC, UBC, SBCCI, BOCA and Life Safety.
- D. Fire performance characteristics: Provide wall protection system components with UL label indicating that they are identical to those tested in accordance with ASTM-E84 for Class A characteristics listed below:
 - 1. Flame spread: 25 or less
 - 2. Smoke developed: 450 or less
- E. Impact Strength: Provide assembled wall protection units that have been tested in accordance with the applicable provisions of ASTM F476.
- F. Chemical and stain resistance: Provide wall protection system components with chemical and stain resistance in accordance with ASTM D-1308.
- G. Single source responsibility: Provide all components of the wall protection system manufactured by the same company to ensure compatibility of color, texture and physical properties.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site in unopened original factory packaging clearly labeled to show manufacturer.
- B. Store materials in original, undamaged packaging in a cool, dry place out of direct sunlight and exposure to the elements. A minimum room temperature of 40°F (4°C) and a maximum of 100°F (38°C) should be maintained.
- C. Material must be stored flat.

1.5 PROJECT CONDITIONS

- A. Materials must be acclimated in an environment of 65°-75°F (18°-24°C) for at least 24 hours prior to beginning the installation.
- B. Installation areas must be enclosed and weatherproofed before installation commences.

PART 2 -PRODUCTS

2.1 MANUFACTURERS (CG)

- A. Subject to compliance with requirements, provide the products specified in individual subparagraphs below as basis-of-design products or a comparable product by one of the following:
1. Basis-of-Design Product: Construction Specialties, Inc.; Acrovyn, CG-1 Corner Guard (CG-1) SM-20AN
 2. Inpro
 3. Pawling Corporation
 4. Koroseal

2.2 MATERIALS

- A. Vinyl or Vinyl/Acrylic compound: Extruded material should be high impact plastic with shadow grain texture. Chemical and stain resistance should be per ASTM D-1308 standards as established by the manufacturer. Colors to be selected from one of manufacturer's standard color range.
- B. Retainers: recycled vinyl or vinyl/acrylic compound.
- C. Fasteners: All fasteners to be non-corrosive and compatible with retainers. All necessary fasteners to be supplied by the manufacturer.
- D. Adhesive: As recommended by protection product manufacturer
1. Adhesives shall have a VOC content of [70] g/L or less.
 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 CORNER GUARDS (CG)

1. (CG-1) – Basis of Design: Model SM-20AN - 90° surface mounted corner guard with 3" (76.6mm) legs and 1/4" (6.4 mm) radiused cover. Select from one of Acrovyn solid colors or Chameleon™ simulated patterns.
2. Provide full height lengths unless indicated otherwise on the drawings

2.4 FABRICATION

1. General: Fabricate corner guards to comply with requirements indicated for design, dimensions, detail, finish and member sizes.

PART 3 – EXECUTION

3.1 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. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface preparation: Prior to installation, clean substrate to remove dirt, debris and loose particles. Perform additional preparation procedures as required by manufacturer's instructions.
- B. Protection: Take all necessary steps to prevent damage to material during installation as required in manufacturer's installation instructions.

3.3 INSTALLATION

- A. 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.
- B. 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.
- C. Adjust installed end caps as necessary to ensure tight seams.

3.4 CLEANING

- A. General: Immediately upon completion of installation, clean vinyl covers and accessories in accordance with manufacturer's recommended cleaning method.
- B. Remove surplus materials, rubbish and debris resulting from installation as work progresses and upon completion of work.

3.5 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 13

SECTION 10 28 13 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all labor, materials, equipment and services required to furnish and install the toilet accessories.

1.2 SUBMITTALS:

- A. Prior to installation, submit to the Architect for review the following:
 - 1. Complete and fully descriptive manufacturer's literature, which shall include a picture of the product, product size, material type and gauge, finish, and installation detail.
 - 2. A complete list of all accessories proposed for use and the room (identified by room number and room name) and the number of accessories of each type installed in that particular area. Include rough-in drawings for recessed accessories and details of backing.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS:

- A. Bradley Corporation
Mt. Laurel, New Jersey

Bobrick Washroom Equipment
Los Angeles, California

AJW Washroom Accessories
New Windsor, NY

An approved equal.

- B. Note: The catalog numbers and descriptive names used in the drawings are those of Bobrick Washroom Equipment unless otherwise noted and are for the purpose of convenience, identification, and establishing standards of quality for materials, construction, dimensions, etc.

2.2 TOILET ACCESSORIES:

- A. See Toilet Accessory Schedule on Drawings.

2.3 FASTENING:

- A. All items of toilet accessories shall be provided complete with all required fastening devices. All fastening devices shall harmonize, in finish, with the item being fastened.

PART 3 – EXECUTION

3.1 INSTALLATION:

- A. Install all toilet accessory units in accordance with manufacturer's instructions, using fasteners, which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations indicated.
- B. Grab bars: Finished installation of grab bars shall be capable of withstanding 250 lbs. of pressure.

3.2 ADJUST AND CLEAN:

- A. Adjust toilet accessories for proper operations and verify that mechanisms function smoothly.
- B. Clean and polish all exposed surfaces after removing protective coatings.

END OF SECTION 10 28 13

SECTION 10 44 00 - FIRE EXTINGUISHERS AND CABINETS

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide all labor, materials, equipment and services required to furnish and install the fire extinguishers and cabinets.

1.2 SUBMITTALS:

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection specialties.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. 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.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of cabinet finish indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire extinguishers and cabinets through one source from a single manufacturer.
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Standard for Portable Fire Extinguishers."
- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide extinguishers listed and labeled by FM.

1.4 COORDINATION:

- A. Coordinate size and type of cabinets to ensure that the type and capacity of fire extinguishers indicated can be accommodated.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS AND CABINETS:

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products by the manufacturer specified in the paragraph below as basis-of-design products or comparable products by one of the following manufacturers:
 - 1. Potter Roemer Industries.
 - 2. J. L. Industries, Inc.

- B. Basis of Design: Larsen's Manufacturing Company, Architectural Series.

2.2 FIRE EXTINGUISHERS:

- A. Type:
 - 1. Multi-Purpose Areas: Dry Chemical Larsen's MP Series MP-10.
 - 2. Kitchen Areas: Wet Chemical Class K Larsen's WC Series WC-6L.
 - 3. Electrical Areas: DC Series Larsen's DC-10 with Larsens Mfg standard bracket B2.

2.3 FIRE EXTINGUISHER CABINETS:

- A. Type: Semi-Recessed-Mounted: Larsen's SS 2409-R4 or approved equal
- B. Door Style: Larsen's Vertical Duo. Stainless Steel Cabinet with clear acrylic vision panel in door.
 - 1. Die Cut Lettering shall be vertical – color by AHJ
- C. Cabinet shall be sized to accommodate extinguisher.
- D. Finish: Stainless Steel

PART 3 - EXECUTION

3.1 GENERAL:

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets are to be installed.
- B. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- C. Comply with manufacturer's written instructions for installing fire-protection specialties.
- D. Install in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction and ADA Standards..
 - 1. Prepare recesses for cabinets as required by type and size of cabinet and trim style.
 - 2. Fasten mounting brackets to structure and cabinets, square and plumb.
 - 3. Fasten cabinets to structure, square and plumb.
- E. Provide final protection and maintain conditions that ensure that cabinets and doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 10 44 00

Division 12 - Furnishings

SECTION 12 24 00 – MANUAL WINDOW SHADES

PART 1 – GENERAL

1.1 SUMMARY:

- A. This Section includes manually operated roller shades with single rollers made from opaque/blackout fabric window shades including, controls, and mounting hardware.

1.2 SUBMITTALS:

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for each type of window shade specified. Include printed data on physical characteristics.
- C. Shop drawings showing locations and extent of window shades. Provide elevations indicating window openings. Show installation details at and relationship to adjoining work. Include plans, elevations, sections, details, details of installation and operational clearances.
 - 1. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 2. Use same designations indicated on Drawings. (All interior & exterior windows).
- D. Indicate location of shade controls.
- E. Samples of manufacturer's colors, finishes, textures, and patterns as scheduled or acceptable manufacturer's closest match:
 - 1. Shade Fabrics for the following: **WC-1**
WC-1, Basis of Design- Mecho Shades; SoHo 5% openness, 1900 Series, as scheduled
Metal Finish: submit all available colors to architects for selection.
- F. Schedule of window shades using same room designations indicated on Drawings. Indicate field verified window dimensions, quantities, type of shade, controls, fabric, and color.
- G. Manufacturer's installation instructions.
- H. Maintenance data for window shades to include in the operation and maintenance manual specified in Division 1. Include the following:
 - 1. Methods for maintaining window shade fabric and finishes.
 - 2. Precautions for cleaning materials and methods that could be detrimental to finishes and performance.

1.3 QUALITY ASSURANCE:

- A. Single-Source Responsibility: Obtain each type of window shade from one source and by a single manufacturer.
- B. Installer shall be qualified to install specified products by prior experience.
- C. Fire-Test-Response Characteristics: Provide products passing flame-resistance testing according to NFPA 701 by a testing agency acceptable to authorities having jurisdiction.
- D. Comply with WCMA A 100.1.

1.4 PROJECT CONDITIONS:

- A. Field Measurements: Check actual window shade dimensions by accurate field measurements before fabrication, and show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Space Enclosure and Environmental Limitations: Do not install window shades until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.
- B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.
- C. Label containers and shades according to Window Shade Schedule.

PART 2 – PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide window shade as indicated here within and on the drawings, Sheet A700.
- B. WC-1, Basis of Design Product: Mecho Manual operating, chain drive, sunscreen single roller shades and related mounting systems and accessories, See finish schedule, A700 for color. Pattern – SoHo 1900 series (5% Open), color: 1905 Dove Grey
- C. Basis of Design Product:
 - 1. Mecho Shade Systems- Mecho / 5x, manually operated single roller solar shade
 - 2. True Performance Manual Solar Shades
 - 3. Heavy duty torsion spring lift
 - 4. Matching fabric contour valance sized to conceal shade roll with returns
 - 5. Mecho/5 Standard Bracket, maximum roll up diameter 2 ¾” Max w or without optional fascia.
 - 6. Matching Fabric Contour Valance sized to conceal shade roll with returns
 - 7. Heat sealed hem bar

8. Finishes: Pattern – Baked Enamel, color- gray
9. Metal finish – 875 clear anodized

D. Acceptable Manufacturers:

1. Mecho Shades: SWF Contract
8467 Route 405 Highway South
Montgomery, PA 17752
Phone: 1.877.792.0002
2. Hunter Douglas
4310 Regency Drive
Bldg 101
High Point, NC 27265
Phone: 1. 336.812.8181
3. Levolor
3 Glenlake Parkway NE,
10th Floor
Atlanta, GA 30328
Phone: 1. 800.752.9677

2.2 MANUALLY OPERATED WINDOW SHADES WITH SINGLE ROLLERS:

- A. A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 1. Bead Chains: #10 Stainless steel.
 2. Loop Length: As required to operate full height of window shade.
 3. Limit Stops: Provide upper and lower round nickel-plated steel ball stops.
 4. Chain-Retainer Type: Locking-style chain retainer restricts the operation of the chain unless the chain retainer is properly mounted to a fixed surface such as a window frame, sill, or wall. Compliant with American National Standard for Safety of Corded Window Covering Products ANSI A100.1. Non-locking P-Clip is not acceptable.
 5. Spring Lift-Assist Mechanisms (SA): Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.
 - a. Provide 6 lb. (2.7 kg) lift assist for shades as recommended by manufacturer.
- B. Rollers: Extruded-aluminum tubes engineered with channel to accept fabric spline. The diameter and wall thickness to be determined by manufacturer based on fabric selection and shade size to provide minimal deflection and optimal performance.
 1. Clutch System: Consists of fiberglass filled nylon for wear resistance, smooth operation and corrosion resistance. The clutch is comprised Velvetrol™ internal spring arrangement for a smooth pulling force that locks the shade in any position when operating the control loop. The clutch mechanism is bi- directional and does not require adjustment or lubrication. Clutch to be inserted in roller tube at manufacturing. Clutch size to be selected by manufacturer based on fabric selection and shade size.
 2. Roller Drive-End Location: Right side of shade.
 3. Direction of Shade Roll: Regular, from back of roller.

4. Fabric-to-Roller Attachment: Removable spline system shall consist of a co-extruded PVC spline heat-welded to the shade fabric and inserted into an engineered channel on the roller tube. The spline system allows for adjustability on-site and ease in changing fabric bands in the field.
 5. Idler End: Constructed of high strength, fiberglass filled nylon with spring-loaded pin-end technology for wear resistance, smooth operation, and corrosion resistance.
- C. Mounting Hardware: Brackets, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
1. Thickness; 16 gauge.
 2. Material: Stamped steel.
 4. Description: Fascia bracket, gray powder coated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to couple up to three inline rollers into a linked shade system that is operable by one roller drive-end assembly. Linking system allows alignment of hem bars without removing shade from brackets by the Infinite Adjuster.
- E. Fabric Bands:
1. Fabric Band Material: Light-blocking fabric.
 2. Fabric Band Bottom (Hem) Bar: Extruded aluminum.
 - a. Type: Hem bars to be extruded aluminum in weight sufficient for proper shade operation. Enclosed in heat sealed pocket of fabric band material.
 - b. Color and Finish: to match Basis of Design.
- E. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller end brackets without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Size: Manufacturer's standard required to conceal roller and fabric band when shade is fully open, but not less than height 3.75 inches (95 mm) by 1.5 inches (38 mm).
 - c. Color and Finish: Clear satin anodized.
 - d. End cap: to cover exposed ends of fascia
 2. Exposed Pocket: Rectangular, extruded aluminum 3-sided enclosure covering front, top and back, with optional end caps, and optional removable bottom closure plate.
 - a. Width 4.75 inches (121 mm) by Height 5 inches (127 mm).
 - b. End cap: to cover exposed ends of pockets.
 - c. Color and Finish: Clear satin anodized.
 3. Recessed Pocket: Rectangular, extruded aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, optional end caps, and optional removable bottom closure plate.
 - a. Width 4.75 inches (121 mm) by Height 5 inches (127 mm) with 0.875 inch (22 mm) tile support.
 - b. Color and Finish: Clear satin anodized.
 4. Closure Plate and Closure Mount: Removable 2 inch (51 mm) or 3 inch (76 mm) closure plate designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to closure mount without fasteners.

- a. Closure-Plate Width: 2 inches.
- b. Closure Mount: Without acoustical tile support.
- c. Color and Finish: Clear satin anodized.
- C. Endcaps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size.
- D. Shade slat: Slat encased in heat seamed hem
- E. Fascia: L shaped aluminum extrusion to conceal shade roller and hardware.
 - 1. Attachment: Snaps onto endcaps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands.
 - 2. Finish: White powder coat

2.3 FABRIC:

- A. Fabric Band Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Basis of Design- SWF Contract; Pattern – Pattern – SoHo 1900 series (5% Open), color: selected from manufacturer's full line of color options.
- C. Metal finish – 875 clear anodized.

2.4 SHADE FABRICATION:

- A. Product Safety Standard: Fabricate roller shades to comply with ANSI - WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows:, measured at 74 deg F (23 deg C):
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed, minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), with an 1/8 inch (3.1 mm) tolerance.

PART 3 – EXECUTION

3.1 PREPARATION:

- A. Field verify window dimensions prior to fabrication.
- B. Coordinate requirements for blocking, construction of shade pockets, and structural supports to ensure adequate means for installation of window shades.
- C. Coordinate installation of recessed shade pockets with construction of suspended gypsum board ceilings specified in Section 09 21 16 – Gypsum Board Assemblies.

3.2 INSTALLATION:

- A. Install window shades at locations indicated on Drawings and approved Window Shade Schedule.
- B. Comply with shade manufacturer's written instructions and approved submittals.

- C. Install roller shades level, plumb, and aligned with adjacent units per manufacturer's written instructions.
 - 1. Opaque Fabric Bands: Located so fabric band is not closer than 2 inches (51 mm) to interior face of glass. Allow clearances for window operation hardware.
- D. Shade pockets where concealed mounting is indicated:
 - a. Install shade pockets in conjunction with installation of ceiling system. Attach to supporting structure with screws through top of pocket at 24 inches' minimum centers.
 - b. Install pocket ends securely and in alignment with pockets.
 - c. After interior construction is essentially complete, install shade and operating mechanism in pocket.
- E. Install fascia and endcaps to conceal roller and operating mechanism where surface mounting is indicated. Do not use exposed fasteners.

3.3 TESTING AND DEMONSTRATION:

- A. Demonstrate operation of shades to Owner's designated representatives.

3.4 PROTECTION:

- A. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensure window shades are without damage or deterioration at the time of Substantial Completion.
- B. If damage occurs, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.
- C. Clean shade assemblies and protect from damage from construction operations.
- D. Remove surplus materials, packaging, rubbish, and debris resulting from installation. Leave installation areas neat, clean, and ready for use.

END OF SECTION 12 24 00

Division 22 – Plumbing

SECTION 22 05 00 - PLUMBING GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 (General Requirements) sections of the Project Manual apply to this Section.
- B. The General Conditions shall be carefully examined before proposals for any work are submitted. Division 22 shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions unless Division 22 sections contain statements more definitive or more restrictive.

1.2 SCOPE

- A. Provide all labor, material, equipment, and services necessary and reasonably incidental to the proper completion and proper operation of the building plumbing systems. The work shall consist of but shall not necessarily be limited to the following:
 - 1. Domestic water system including extension of piping and connections to all fixtures and/or equipment. The domestic water system shall be extended from a point 5 (five) feet beyond the exterior face of the building.
 - 2. Sanitary drain, waste and vent system including extension of piping and connection to all fixtures and/or equipment. The sanitary system shall be extended to a point 5 (five) feet beyond the exterior face of the building.
 - 3. Rainwater collection system including downspout boots from gutters and downspouts. The rainwater collection system shall be extended to a point 5 (five) feet beyond the exterior face of the building.
 - 4. Natural Gas system including extension of piping and connections to gas fired plumbing equipment, HVAC equipment, etc. The natural gas system shall extend from the gas meter, by service provider, to the building.

1.3 DEFINITIONS

- A. Words and phrases used throughout the Contract Documents shall be interpreted as indicated below:
 - 1. Construction Documents – the basis for the work. It includes both the Drawings (plans) and Project Manual (specifications).
 - 2. Contractor – The person or organization awarded the contract for construction services.

In the case of a construction project administered as a multiple-prime contract, the term shall be further defined as the Contractor holding a prime contract for plumbing construction work.

The term “Plumbing Contractor” is used interchangeably with the term “Contractor”.
 - 3. Provide – To furnish and install materials, equipment, or systems.
 - 4. Submittals – Submittals shall include Manufacturer’s Catalog Data, Shop Drawings, Calculations, Certificates of Compliance, Testing Reports, Samples, and Operation and Maintenance Manuals.

5. Professional – The Architect and/or Engineer of record.
6. Work By Others – Work provided by a person or organization other than the Contractor.

1.4 CODES, REFERENCES AND STANDARDS

- A. The Contractor shall comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction, including those of all applicable City, County, State, Federal and Public Utility entities. All licenses, permits, fees, connection fees, tapping fees, inspection fees, etc., shall be obtained by the Contractor and the cost shall be included in the Contract price.
- B. The minimum standard of work under this contract shall be in accordance with the following model building codes:
 1. North Carolina State Building Codes 2018 Edition:
 - a. North Carolina State Building Code.
 - b. North Carolina State Plumbing Code.
 - c. North Carolina State Mechanical Code.
 - d. North Carolina State Fire Prevention Code.
 - e. North Carolina State Fuel Gas Code.
 - f. North Carolina State Energy Code.
- C. Other publications listed throughout Division 22 form a part of this specification to the extent referenced. All publications shall be in the latest edition as adopted by the Authority Having Jurisdiction. The publications are referred to in the text by basic designation only.

1.5 QUALITY ASSURANCE, WORKMANSHIP AND COORDINATION

- A. The Contractor must coordinate his work with that of the other trades so that all work will be performed in an orderly manner and with the least possible interference. Where coordination with other trades is required, the Professional shall make the final decision regarding changes to be made in the work.
- B. The Contractor must thoroughly familiarize himself with all the Construction Documents for the project so that he clearly understands his responsibility in relationship to the work to be performed. The Contractor must plan and perform his work to permit the use of the building as soon as possible.
- C. The Contractor shall guarantee the workmanship, materials, and equipment, furnished against defects, leaks, performance and non-operation for a period of one (1) year after the date of final acceptance. Defective workmanship shall be construed as meaning defective materials and unsatisfactory installation and not intended to apply to ordinary wear and tear. The Contractor shall pay for any repairs or replacements caused by defective workmanship as construed herein within the period covered by the Guarantee, including all incidental work required to correct the deficiency.
- D. The Contractor shall expressly and completely follow all manufacturers' instructions required for validation of the manufacturer's warranty agreement including but not limited to service, maintenance and adjustments of the equipment.

- E. The Contractor shall be held responsible for the proper installation of all materials and equipment required for a complete installation within the intent and meaning of the Contract Documents.

1.6 PROJECT RECORD DRAWINGS

- A. Changes from the Contract Drawings necessary to coordinate the work with other trades, to conform to the building conditions or to conform to the rules and regulations of Authorities Having Jurisdiction shall be made only after obtaining written permission from the Professional.
- B. The Contractor shall keep a record of construction changes and deviations from the original Contract Drawings. All changes shall be recorded on a separate set of prints which shall be kept at the job site specifically for that purpose. The record shall be made immediately after the work is completed. Documentation shall include:
 - 1. location and elevation of new and existing utility lines
 - 2. points of connection to existing utility lines
 - 3. changes in pipe routing location
 - 4. valve locations
 - 5. equipment locations, etc.
 - 6. actual capacities and values of equipment provided as indicated in equipment schedules.
- C. The marked-up record set of drawings shall be delivered to the Professional before final acceptance of the Plumbing Contract work.

1.7 FIELD MEASUREMENTS

- A. It shall be the Contractor's responsibility to verify the location of any and all existing underground utilities in the vicinity of his work. When it has been indicated that these utilities are to remain in place, the Contractor shall provide adequate means of support and protection during excavation operations.
- B. Before ordering any equipment and material, or performing any work, the Contractor shall verify all measurements and dimensions at the job site and shall be held responsible for the correctness of same.
- C. No extra compensation will be allowed because of differences between actual dimensions and measurements and those indicated on the drawings.
- D. Any difference which may be found shall be submitted to the Professional for consideration before proceeding with the work.

1.8 PROTECTION OF SERVICES AND EQUIPMENT

- A. The Contractor, at his own expense, shall repair, replace, and maintain in service any utilities, facilities or services (underground, aboveground, interior or exterior) damaged, broken, or otherwise rendered inoperative during construction due to activities on the part of the Contractor. The method used by the Contractor in repairing, replacing, or maintaining the services shall be approved by the Professional.

- B. The Contractor shall protect, at his own expense, such of his work, materials or equipment that is subject to damage during the project duration. All openings into any piping, ducts or equipment must be securely covered, or otherwise protected, to prevent injury due to carelessly or maliciously dropped tools or materials, grit, dirt, or any foreign material. The Contractor shall be held responsible for all damage so done until his work is fully and finally accepted.
- C. It shall be the responsibility of the Contractor to protect motors, pumps, electrical equipment, and all similar items of equipment from dirt, grime, plaster, water, etc. during all phases of construction. This protection shall be provided by covering equipment with transparent plastic sheeting and/or locating the materials and equipment in an area free from the elements.

1.9 INTERRUPTION OF SERVICES

- A. The Contractor shall schedule his work to avoid any major interruption of any utility services.
- B. Existing utilities serving facilities occupied and used by the Owner or others shall not be interrupted except when such interruptions have been authorized in writing by the Owner or the Professional. Interruptions shall occur only after acceptable temporary utility services have been provided. The Contractor shall provide a minimum of ten (10) working days notice to the Professional and receive written notice to proceed before interrupting any utility.

1.10 CLEANUP

- A. The Contractor shall maintain buildings, grounds, and public properties free from accumulations of waste materials, debris, and rubbish. At reasonable intervals during the progress of work, and when directed by the Owner's Authorized Representative, the site and public properties shall be cleaned and waste materials, debris and rubbish shall be disposed of in an appropriate manner. The Contractor shall provide containers for collection of waste materials, debris, and rubbish. Waste materials, debris and rubbish shall be removed from the job site and legally disposed of at a landfill area in accordance with all applicable regulations. Burning or burying waste materials, debris or rubbish on the project site shall not be permitted.
- B. At the completion of the Project, remove waste materials, rubbish, tools, equipment, machinery, surplus materials, etc., and clean all sight-exposed plumbing fixtures and equipment. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from sight-exposed plumbing fixtures and equipment. Broom clean paved and concrete surfaces; rake clean other ground surfaces. Repair, patch, and touch up marred surfaces to specified finish or to match adjacent surfaces.

1.11 SUBMITTALS

- A. Submittals shall be in accordance with Division 01 of the Project Manual.
- B. General
 - 1. The Contractor shall provide to the Professional for review electronic (pdf file format) copies of required submittals, unless noted otherwise. All Catalog Data, Shop Drawings, Calculations, and Certificates of Compliance shall be submitted as a single package. Failure of the contractor to provide a complete submittal package may result in delay in processing time. All such delays to the job resulting from the contractor's failure to provide submittals at one time will be the responsibility of the Contractor.

Submittals will be returned to the Architect / Contractor. Submittals shall clearly identify the contract documents specification section or drawing referenced, identifying and highlighting each item to be reviewed.

2. Submittals provided for review shall clearly and completely describe the specific product(s) they represent. Where differences exist between the item specified and that submitted for review, the submittal shall be highlighted.
3. Submittals shall bear the review stamp of the Contractor. The review stamp of the Contractor shall be affixed to shop drawings to indicate:
 - a. The Contractor has coordinated the electrical characteristics of the equipment.
 - b. The Contractor has verified that the equipment submitted will physically fit into the space allocated with adequate clearances for maintenance, access, and egress requirements.
 - c. The Contractor shall bear all associated costs that may accrue due to failure to completely represent a given product.
4. Material and equipment shown on the drawings or specified herein shall not be incorporated in the work of this Contract until shop drawings, engineering data and catalog information have been reviewed and accepted by the Professional.

C. Trade Name References

1. Material and equipment are described and listed in the Project Documents by trade name, by manufacturer's name and model number, or by performance attributes. It is intended that trade names or manufacturer's names shall establish standards of quality, performance, capacity, materials, and design for the item specified.
2. Where more than one manufacturer is listed for an item, those mentioned are considered equivalent if the quality, style, capacities, materials, and performance of the specified item are equivalent. All materials and equipment shall be subject to the acceptance by the Professional.

D. Substitutions

1. No substitution shall be made without the review and acceptance by the Professional.
2. Where the phrase "or accepted substitute" or "or equal" appears in the Contract Documents, it shall refer to the requirement of acceptance by the Professional of the material or equipment involved.
3. It shall be the responsibility of the Contractor to ensure that each manufacturer can furnish a substitute in complete conformity with the requirements of this Project. The Contractor shall assume all costs or extra charges associated with the substitution, including: any architectural, structural, mechanical, or electrical changes required, costs in connection with work of the other trades necessitated substitutes, and any additional engineering costs required.
4. The Contractor shall indicate the specified equivalent on shop drawings or catalog data which are submitted as substitutions.
5. At the request of the Professional samples of items that are to be used in substitution of specified items shall be submitted. If such a request is made, a sample of both the specified item and the proposed substitute item shall be submitted simultaneously.

The scheduling of the submission of such samples shall be as directed and shall in no way delay the progress of the project. The Professional will assume no liability whatsoever for any samples submitted.

E. Operation and Maintenance Manuals

1. Submit two (2) sets of 8-1/2" x 11" text sixty (60) days prior to operator training/pre-final inspection bound in three D side ring capacity expansion binders with durable plastic covers for review by the Professional.
2. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.
3. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
4. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified type on thirty (30) pound white paper.
 - a. Part 1: Directory, listing names, addresses, and telephone numbers of Professional, Contractor, Subcontractors, and equipment suppliers.
 - b. Part 2: Operation and maintenance instructions arranged by system or process floor and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - 1) Significant design criteria.
 - 2) List of equipment.
 - 3) Parts list for each component.
 - 4) Maintenance instructions for equipment and systems.
 - 5) Maintenance instructions for finishes, including recommended cleaning methods and materials and Operating instructions.
 - 6) Special precautions identifying detrimental agents.
 - 7) Special Requirements of other sections of this specification noted to be included in the operating and maintenance manual.
 - c. Part 3: Project documents and certificates, including the following:
 - 1) All approved Submittals
 - 2) Certificates of Compliance
 - 3) Photocopies of warranties and bonds
 - 4) Material safety data sheets
5. Submit five (5) copies of completed volumes in final form fifteen (15) days prior to owner training. These copies will include Professional's previous review comments.
6. Submit eight final volumes revised, within ten (10) days after pre-final observation.

F. Samples

1. The Contractor shall furnish, for review by the Professional, all samples specified or requested by the Professional. The finished work shall match accepted samples and shop drawings.

1.12 ELECTRICAL EQUIPMENT

- A. The Contractor shall furnish all motors, combination starters/disconnects, overload protection and controls for equipment required to provide complete and workable systems, unless noted otherwise.
- B. All motors, motor control equipment and wiring shall meet the requirements of the National Electric Code and shall comply with the requirements of the Public Utility Company furnishing service and with the rules and regulations of all Authorities Having Jurisdiction.
- C. The contractor shall verify electrical characteristics at the site before ordering electrical equipment.
- D. Motors under ½ (one-half) horsepower shall be 120 volts. Motors ½ (one-half) horsepower and over shall be 3 (three phase. All motors to be 1750 revolutions per minute (rpm) unless noted otherwise. Combination motor starters shall of the fused switch type to complete with magnetic motor starter. Units shall be of the NEMA size and type applicable to motor size, with 3-pole overload. Overload elements and fuses shall be of the proper size to protect the motor. Unless noted otherwise, units shall be equipped with indicating lights, HAND-OFF-AUTOMATIC (HOA) selector switch, 4 (four) auxiliary contacts 2 (two) normally open (N.O.) and 2 (two) normally closed (N.C.) and fused control transformer to provide 120-volt control voltage. Fusible disconnect switch operating handles shall be interlocked with the door so that the door cannot be opened with the switch in the "ON" position, except through a hidden release mechanism. The operating handle shall be arranged for padlocking in the "OFF" position with up to three padlocks. Fuses shall be furnished by the Contractor as required to comply with NEC requirements. Where R type fuses are indicated, fuse holders shall be provided with rejection clips. Equipment shall be Square D, Allen-Bradley, or General Electric or accepted substitute, and shall be provided with a NEMA Type 1 enclosure, unless noted otherwise.

1.13 CONTROL WIRING

- A. The Contractor shall provide all necessary control wiring and related conduit required for complete and workable systems.
- B. All conduit and wiring shall be in accordance with the latest edition of the National Electrical Code. Installation of control wiring shall be performed in a neat and workmanlike manner by competent workmen. Workmanship shall be as specified in Division 26.
- C. Control circuits shall be wired for 110-volt control, using fused individual control transformers. Circuits shall be fused and shall be interrupted when the disconnect device is opened.

1.14 EXCAVATION, BACKFILLING AND COMPACTION

- A. Excavation, Backfilling and Compaction shall comply with Division 31 of the Project Manual

B. General

1. The Contractor shall notify one call prior to any work.
2. The Contractor shall perform all excavation, backfilling, compaction and necessary finishing for all piping, equipment, and accessories. Piping installation shall be in accordance with local water, sewer and gas utility regulations and applicable State and Local codes.
3. Protect existing structures, utilities, sidewalks, pavements and other facilities not indicated for removal, from damage caused by settlement, lateral movement, undermining, washout and other hazards resulting from excavation operations.
4. Existing utility lines shown on the Project Documents may not indicate the exact in-place location of the lines. They do not show every pipe, fitting or appurtenance that may exist at the project site. The location and depth of all utilities shall be marked and recorded prior to any excavation. Should uncharted or incorrectly charted, existing piping or other utilities be uncovered during excavation, contact the Professional immediately for directions before proceeding further with work in this area. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.
5. If it becomes necessary to install any lines or equipment in locations other than those shown, the Professional's acceptance shall be obtained before starting the excavation.
6. The presence of explosives on the project site or the use of explosives in the execution of the work under this contract is not permitted.

C. Excavation

1. All plumbing excavations are unclassified.
 - a. Paved Areas – When working within the right-of-way limits of all North Carolina State highways, backfilling must be in conformance with the requirements of the North Carolina Department of Transportation, which is made a part of these specifications by this reference thereto.

D. Compaction

1. Comply with Division 31 of the Project Manual.

1.15 CONCRETE

- A. Comply with Division 03 of the Project Manual.
- B. Reinforcing shall conform to ASTM A-615, Grade 60. Concrete exposed to freezing and thawing, salts, sulfates, and corrosion shall comply with the International Building Code with North Carolina amendments.
- C. All concrete shall be of a minimum of 3000 pounds per square inch (psi) strength in 28 (twenty-eight) days. All concrete shall be mixed by machine. No wet or moistened mixture containing cement shall remain unplaced for a period exceeding 30 (thirty) minutes and shall not be used after its initial set. Re-tempering after the initial set is prohibited. Exposed surfaces shall be protected from drying for at least 7 (seven) days. All forms shall be built true and rigid. Form removal shall not injure the concrete.

- D. All concrete is to be finished with a hard, smooth troweled finish and is to be faced smoothly with rounded corners.

1.16 INSPECTION AND TESTING

A. General

1. New plumbing systems and parts of existing systems which have been altered, extended, or repaired shall be tested to disclose leaks and defects.
2. The Contractor shall notify the Professional a minimum of 5 (five) working days prior to testing to coordinate the testing and inspection procedures.
3. If the Professional determines that the plumbing systems do not pass the prescribed tests, then the Contractor shall be required to make the necessary repairs, at his own expense, and the Contractor shall re-inspect and re-test the systems. Repairing, inspection and testing shall be continued until all systems pass as determined by the Professional.
4. All new, altered, extended, or replaced plumbing shall be left uncovered and unconcealed until it has been inspected, tested, and accepted by the Professional. Where such work has been covered, or concealed before it has been inspected, tested, and accepted, it shall be uncovered by the contractor, at his own expense as directed by the Professional.
5. All equipment, material, labor, etc., required for testing the plumbing systems shall be furnished by the Contractor.
6. The Engineer or Engineer's representative is the inspector for the state. The Engineer or Engineer's representative shall witness all pipe installations, pressure tests, etc. Underground piping shall be kept uncovered until all testing has been completed and the installation methods have been approved. If the underground pipe is covered before approval, it shall be uncovered at the Contractor's expense for inspection and testing.

B. Sanitary, Vent, and Rainwater Collection Systems

1. The system shall be tested in accordance with the North Carolina State Plumbing Code.
2. Rough Plumbing – Systems shall be tested upon completion of the rough piping installation and proved watertight. The water test shall be applied to the system either in its entirety or in sections after rough piping has been installed.
 - a. Where applied to the entire system, all openings in the piping shall be closed, except the highest opening, and the system filled with water to the point of overflow.
 - b. Where the system is tested in sections, each opening shall be plugged, except the highest opening of the section under test, and each section shall be filled with water. A section shall not be tested with less than a 10-foot head of water.
 - c. In testing successive sections, at least the upper 10-feet of the next preceding section shall be tested, such that a joint or pipe in the building, except the uppermost 10 feet of the system, shall not have been subjected to a test of less than a 10-foot head of water.

- d. The water shall be kept in the system or in the portion under test for a minimum of 2 (two) hours before inspection starts. The system shall then be inspected to ensure that it is tight at all points.
 - e. The Contractor shall provide a written Test and Inspection Report that the above prescribed test(s) have been performed in accordance with these Specifications. The report is subject to approval by the Professional.
3. Finished Plumbing – After the plumbing fixtures have been set and their traps filled with water, the plumbing fixture connections shall be tested and proved gas and watertight.
- a. A smoke test shall be made by filling all traps with water and then introducing into the system smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be introduced and maintained for the period of the inspection.
 - b. Where the local Authority Having Jurisdiction finds that a smoke test need not be performed, a peppermint test shall be performed. Two (2) ounces of oil of peppermint shall be poured into the roof terminal of every line or stack to be tested. The oil of peppermint shall be followed at once by 10 quarts of hot (140-degrees Fahrenheit) water. All roof vent terminals shall then be sealed. The system shall then be inspected for the detection of odor of peppermint. If odor of peppermint is detected, repairs shall be made, and the system shall be retested.
 - c. The above tests shall be witnessed by the Authority Having Jurisdiction or by a Professional or his representative.
 - d. The Contractor shall provide a written Test and Inspection Report that the above prescribed test(s) have been performed in accordance with these Specifications. The report is subject to approval by the Professional.
- C. Building Sewer
1. The building sewer shall be tested by insertion of a test plug at the point of connection with the public sewer. The building sewer shall then be filled with water under a head of not less than 10-feet. The water level at the top of the test head of water shall not drop for at least 15 (fifteen) minutes.
- D. Domestic Water Systems
1. The system shall be tested either in its entirety or in sections.
 2. The system shall be tested and proved tight under a water pressure of 125 pounds per square inch for a period of 2 hours.
 3. Potable water shall be used for testing.
- E. Fuel Gas Systems
1. The systems shall be tested in accordance with NFPA 54.
 2. All fuel gas piping shall be pneumatically tested for tightness prior to commencement of gas service. Air or nitrogen shall be used as the test medium. The piping system shall be pressurized to 100 psig for a period of 2 hours. All

joints shall be leak tested with detection solution while the system is pressurized. The Contractor shall provide a valved ¼ inch FPT connection in the system to which shall be attached a 24-hour pressure recording gauge. The Contractor shall arrange for a gas company representative to witness the test. Leaks shall be repaired by tightening or replacing joints. Caulking joints are not permitted.

1.17 STERILIZATION OF THE DOMESTIC WATER SYSTEM

- A. After the system has been tested and approved, the entire new system, including valves and accessories, shall be chlorinated. Disinfecting shall be in accordance with AWWA C651.
- B. Chlorine may be applied in any of the following forms:
 - 1. Liquid chlorine gas-water mixture
 - a. Chlorine gas-water mixture shall be applied by a solution feed chlorinating device.
 - 2. Direct chlorine gas feed
 - a. Chlorine gas shall be fed directly from a chlorine cylinder with a suitable device for regulating the rate of flow and the effective diffusion of gas within the line.
 - 3. Calcium hypochlorite and water mixture.
 - a. Calcium hypochlorite shall be HTH, Perchlorene and Maxochlor, or accepted substitute. A solution consisting of five (5%) percent powder to ninety-five (95%) percent water by weight shall be prepared. The calcium hypochlorite and water mixture, first made into a paste and then thinned to a slurry, shall be injected or pumped into the system.
- C. The system or part thereof shall be filled with a water/chlorine solution containing at least 50 parts per million of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million of chlorine and allowed to stand for 3 hours. During the chlorination process all valves and accessories shall be operated.
- D. After the chlorination process, the chlorine shall be flushed from the system until the system water is equal in chemical and bacteriological composition to those of the permanent source of water supply.
- E. Laboratory tests of the water shall be paid for by the Contractor.

1.18 INSTRUCTION OF THE OWNER

- A. After acceptance of the Project, the Contractor shall furnish the services of personnel thoroughly familiar with the completed installation to instruct the Owner in the proper operation and maintenance of all equipment and appurtenances provided.
- B. The Contractor shall provide the Owner with two weeks' notice before the instruction session.

1.19 CHASES AND OPENINGS

- A. All chases and openings required for the installation of the work shall be coordinated with the other trades. The Contractor shall provide the other trades with sufficient time (1 (one) week minimum) for coordination of all chases and openings. The contractor shall be responsible for all work required to cut and patch the required openings. The work shall be performed to the satisfaction of the Professional.
- B. Penetrations made in fire rated chases, partitions, floors, etc. shall be sealed with an approved material and method as required to maintain the integrity of the fire separation.
- C. The Contractor shall provide all sleeves, hangers, and anchors required for installation of the work in chases and openings.

1.20 PAINTING

- A. Painting shall be in accordance with Division 09.

1.21 RELATED WORK

- A. All work related to providing complete plumbing systems and equipment shall be the responsibility of the Contractor. The following related work shall be provided as indicated in other specification Divisions, unless noted otherwise, but shall remain the responsibility of the Contractor for workmanship and completeness:
 - 1. General Contractor
 - a. Installation of access panels.
 - b. Leaders and gutters.
 - c. Equipment and furnishings including shop equipment and laboratory equipment. Final connections to all equipment and furnishings shall be provided by the Contractor. The Contractor shall be responsible for coordination of plumbing services with the equipment and furnishings.
 - d. Installation and flashing of roof penetrations including but not limited to roof drains, vents through roof, gas piping, etc. Final connections shall be provided by the Contractor.
 - e. Concrete housekeeping pads for plumbing equipment.
 - 2. Mechanical Contractor
 - a. Condensate drain piping.
 - 3. Electrical Contractor
 - a. Installation of all combination starters/disconnects and overload protectors.

1.22 MISCELLANEOUS STEEL AND ACCESSORIES

- A. The contractor shall provide all necessary steel angles, channels, pipes, rods, nuts, bolts, etc., as shown on plans, as specified, or as may be required for complete and proper installation of plumbing fixtures, systems, and equipment. All material and workmanship shall be of the best quality and shall be in accordance with the best practices of the trade.

1.23 ACCESS PANELS

- A. The Contractor shall furnish access doors to the General Contractor for installation in ceilings, walls, partitions, and floors for access to valves, traps, fittings, and all appurtenances.
- B. Access panels shall be of sufficient size to permit removal or access to equipment, except that the minimum size shall be 12-inches by 16-inches.
- C. Access door locations shall be as determined by field conditions for optimum access to equipment and shall be reviewed by the Professional before final installation and shall be subject to the following.
 - 1. Bottom of access doors shall not be lower than the top of the partition base, or a minimum of 6 inches above floor.
 - 2. The tops and/or sides of access panels shall be a minimum of 6-inches from the ceiling or opening or from the edge of a wall return.
- D. Access doors shall be suitable for installation in the finished material of the ceilings, walls, partitions, and floors.
- E. Frame and panel access doors in restrooms, kitchens and as indicated shall be stainless steel.
- F. Access doors with UL Listing shall be provided in rated construction assemblies. Access doors shall be "B-Label" and shall have a UL one and one-half (1-1/2) hour rating at 250 degrees F rating for both door and frame. Maximum size shall be 20" x 20" or 400 square inches in area. The frame shall be sixteen (16) gauge minimum steel, panel shall be twenty (20) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), continuous type hinge on one side, flush-face type lock with key operation and self-latching cylinder locks.
- G. Access doors without UL label shall be provided in all non-rated construction assemblies: Frame shall be sixteen (16) gauge minimum steel, panel shall be fourteen (14) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), concealed spring type hinges and flush-face type lock with key operation and self-latching cylinder locks. Door shall open 175 degrees (minimum).
- H. All access doors shall be keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials used on plumbing systems shall comply with the following lead ban requirements:
 - 1. Solders with lead content exceeding 0.2% (two-tenths of a percent) are prohibited. Brass and bronze materials containing 8.0% (eight percent) or greater lead are prohibited.

PART 3 - EXECUTION

3.1 GENERAL

- A. All materials and equipment used shall be installed in strict accordance with the Standards under which the materials are accepted and approved, and in strict accordance with the manufacturer's instructions.

- B. The Contract Documents are not intended to indicate every bend, offset, change in direction and appurtenance required to provide a complete and workable system.
- C. The contract drawings are diagrammatic and are indicative of the work to be performed. It is not intended that they show every pipe, fitting or apparatus required for a complete installation.
- D. Except where otherwise indicated, minimum cover shall not be less than the following:
 - 1. sanitary sewer piping: 3'-0"
 - 2. storm sewers: 1'-0"
 - 3. water piping: 3'-0"
 - 4. gas piping: 2'-0"

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.3 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 22 05 00

SECTION 22 05 03 - PLUMBING PIPE, TUBE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following systems:

1. Domestic water piping within 5 feet of a building.
2. Sanitary waste and vent piping, within 5 feet of the building.
3. Storm water piping within 5 feet of building.
4. Equipment drains and overflows.
5. Natural Gas piping.
6. Unions and flanges.
7. Underground pipe markers.

B. Related Sections:

1. Division 08 - Access Doors and Frames
2. Division 09 - Painting
3. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
4. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
5. Section 22 07 00 - Plumbing Insulation.
6. Division 31 - Excavation, Trenching and Backfill

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
3. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
4. ASTM B75 - Standard Specification for Seamless Copper Tube.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
6. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
7. ASTM D1784 – Rigid Chlorinated Poly (Vinyl Chloride) (CPVC) Vinyl Compounds.

8. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 9. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 10. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
 11. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
- E. Cast Iron Soil Pipe Institute:
1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 2. CISPI 310 – Standard Specification for Couplings for use with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 3. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe institute (CISPI) and be listed by NSF International.

1.3 SUBMITTALS

- A. Division 01 - Submittal Procedures.
- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
- D. Welders' Certificate: Include welders' certification of compliance with ASME Section IX.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum 10 years documented experience.
- C. Design pipe hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain it in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Division 01 - Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

Pipe 1 inch to 3 inch in size:

- A. Copper Tubing: ASTM B88, Type K hard drawn or annealed.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints:
 - a. 2" and smaller: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
 - b. 2-1/2" and larger: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

Pipe 1 inch and smaller:

- B. Copper Tubing: ASTM B88, Type K soft annealed seamless copper tubing (ASTM B88) with no joints.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L hard drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 2. Joints:
 - a. 2" and smaller: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
 - b. 2-1/2" and larger: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
 3. Copper Press-Connect Fittings:
 - a. Basis of Design Product:
 - 1) Viega Propress
 - 2) Apollo Xpress
 - 3) NIBCO
 - b. Fittings for NPS 2 and smaller: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - c. Fittings for NPS 2-1/2 to NPS 4: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - d. Press Ends: Unpressed fitting identification feature to the fitting wall.
 - e. Sealing Element: EPDM.

2.3 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot end.
1. Fittings: Cast iron, ASTM A74.
 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
- B. Cast Iron Pipe: CISPI 301, hub-less.
1. Fittings: Cast iron, CISPI 301.
 2. Joints: CISPI 310, ASTM C1540-15, Heavy-Duty assemblies of corrugated stainless-steel shield/housing, stainless steel bands with corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center stop.
 - a. Accepted Manufacturers:
 - 1) NDS Clamp-All
 - 2) Anaco-Husky
 - 3) Mission Rubber Company
 - 4) Mifab MI-QXHUB

Do not use PVC pipe for high temperature wastewater (140° F or higher).

C. PVC Pipe: ASTM D2665, Schedule 40, solid wall, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.

1. Fittings: ASTM D2466, Schedule 40, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

2.4 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hub-less, service weight.

1. Fittings: Cast iron, CISPI 301.
2. Joints: CISPI 310, ASTM C1540-15, Heavy-Duty assemblies of corrugated stainless-steel shield/housing, stainless steel bands with corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center stop.
 - a. Accepted Manufacturers:
 - 1) NDS Clamp-All
 - 2) Anaco-Husky
 - 3) Mission Rubber Company
 - 4) Mifab MI-QXHUB

B. Copper Tube: ASTM B306, DWV.

1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

C. Copper Tube: ASTM B306, DWV.

1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.5 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74, service weight, bell and spigot end.

1. Fittings: Cast iron, ASTM A74.
2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hub-less, service weight.

1. Fittings: Cast iron, CISPI 301.
2. Joints: CISPI 310, ASTM C1540-15, Heavy-Duty assemblies of corrugated stainless-steel shield/housing, stainless steel bands with corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center stop.

C. PVC Pipe: ASTM D2665, Schedule 40 polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.

1. Fittings: PVC, ASTM D2665.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

- D. PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679, polyvinyl chloride (PVC) material.
 - 1. Fittings: PVC, ASTM D2665, ASTM D3034, or ASTM F679.
 - 2. Joints: ASTM F477, elastomeric gaskets.

2.6 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type DWV.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
 - 3. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted).
 - 4. Joints: Grooved mechanical couplings meeting ASTM F1476.
 - a. Housing Clamps: ASTM A536 ductile iron, cast with offsetting, angle-pattern bolt pads to provide rigidity, copper-colored enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion. "Installation-Ready" design for direct stab installation without field disassembly. Victaulic Style 607 QuickVic™.
 - b. Gasket: Grade "EHP" EPDM gasket for water service with operating temperature range from -30 degrees F to 250 degrees F or Grade "T" Nitrile gasket for oil service with operating temperature range from -20 degrees F to 180 degrees F.
 - c. Accessories: Stainless steel bolts, nuts, and washers.

2.7 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.
 - 3. Press-Connect Fittings: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria ANSI LC-4/CSA 6.32. Sealing elements for press fittings shall be HNBR. Sealing elements shall be factory installed or an alternative supplied by the fitting manufacturer. Press ends shall have SC (Smart Connect) technology design (leakage path). The function of this feature is to provide the installer with quick and easy identification of connections which have not been pressed prior to putting the system into operation.

2.8 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Copper Piping: Class 150, bronze unions with soldered joints.
 - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
 - 2. Copper Piping: Class 150, slip-on bronze flanges.
 - 3. Gaskets: 1/16-inch-thick preformed neoprene gaskets.
- C. Flange Adapter for Pipe 2 inches and Larger:
 - 1. Ferrous Piping: Class 125, 150 & 300, ductile iron, flat faced.
 - 2. Copper Piping: 300 psi, ductile iron coated with copper-colored enamel, flat faced.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Division 01 - Verification of existing conditions before starting work.
- B. Verify excavations are to required grade, dry, and not over-excavated.
- C. Verify trenches are ready to receive piping.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to site piping system size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 2 ft of cover.
- C. Establish minimum separation from other services in accordance with applicable codes.
- D. Install plastic pipe as required per ASTM D2321.
- E. Install pipe to elevation as indicated on Drawings.

- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Install plastic ribbon tape continuous, buried 12 inches below finish grade and above pipeline; coordinate with Division 31. Refer to Section 22 05 00.
- J. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 22 05 00.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls, and floors. Refer to Section 22 05 29.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
- G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08.
- H. Install non-conducting dielectric connections wherever joining dissimilar metals.
- I. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum (1/4 inch per foot for 2" pipes). Maintain gradients.
- J. Slope piping and arrange systems to drain at low points.
- K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- M. Install valves in accordance with Section 22 05 23.
- N. Insulate piping. Refer to Section 22 07 00.
- O. Install pipe identification in accordance with Section 22 05 53.
- P. Press-Fitting joint systems shall be installed in accordance with the manufacturer's guidelines and recommendations. Contractor shall be trained by manufacturer for Press-Fittings application.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

- A. Install domestic water piping system in accordance with ASME B31.9.
- B. Pipes carrying pressurized water and laid under the building shall be installed with NO joints.

3.6 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

- A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.
- B. Install sanitary waste and vent piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.

3.7 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS

- A. Install storm drainage piping systems piping in accordance with ASME B31.9.
- B. Install storm drainage piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.

3.8 INSTALLATION - GAS PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide support for utility meters in accordance with the requirements of utility company.
- C. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
- D. Install gas pressure regulator vent full size opening on regulator and terminate outdoors or as indicated on Drawings.

3.9 FIELD QUALITY CONTROL

- A. Refer to Division 01 - Execution and Closeout Requirements: Field inspecting, testing, and adjusting.
- B. Evaluate domestic water piping system in accordance with applicable code. Refer to Section 22 05 00.
- C. Evaluate sanitary waste and vent piping system in accordance with applicable code. Refer to Section 22 05 00.
- D. Evaluate storm drainage piping system in accordance with applicable code. Refer to Section 22 05 00.
- E. Pressure test natural gas piping in accordance with NFPA 54.

3.10 CLEANING

- A. Division 01 – Execution and Closeout Requirements: Field inspecting, testing, and adjusting.
- B. Clean and disinfect domestic water distribution system in accordance with Section 22 05 00.

END OF SECTION 22 05 03

SECTION 22 05 15 - PLUMBING SPECIALTIES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleanouts
2. Floor Drains
3. Downspout Boots
4. Hose Bibbs
5. Wall Hydrants
6. Trap Primers
7. Water Hammer Arrestors
8. Thermometers
9. Pressure Gauges
10. Balancing Valves
11. Thermostatic Mixing Valves

B. Related Sections:

1. Division 08 - Access Doors and Frames
2. Division 09 – Painting
3. Section 22 05 03 – Plumbing Pipe, Tube and Fittings
4. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
6. Section 22 07 00 - Plumbing Insulation.
7. Division 31 - Excavation, Trenching and Backfill

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 SUBMITTALS

- A. Division 01 - Submittal Procedures.
- B. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- C. All domestic water specialties shall be Lead-Free compliant products designed and manufactured to comply with ANSI / NSF 372 and NSF 61, Annex G.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain it in place until installation.
- C. Storage of Specialties on site – Specialties are not exposed to the elements and shall not be stored directly on ground.

1.6 DEFINITIONS

- A. HDPE: High-density polyethylene plastic
- B. PE: Polyethylene plastic
- C. PP: Polypropylene plastic

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Floor Cleanouts
 1. Approved manufacturers: Zurn, JR Smith, Wade
 2. Coated cast-iron body, gas and watertight ABS tapered thread plug, and round scoriated secured nickel bronze top adjustable to finished floor.
 3. Carpeted Areas: Provide cleanout with carpet marker.
 4. Tile Floor Areas: Provide cleanout with square top recessed for 1/8" tile.
 5. Terrazzo Floor Areas: Provide cleanout with round top recessed for 1-1/4" terrazzo.
 6. Standard: ASME A112.36.2M
 7. Size: Same as connected branch up to 4". Use 4" cleanouts for connected branch sizes larger than 4".
- B. Wall Cleanouts
 1. Approved manufacturers: Zurn, JR Smith, Wade
 2. Standard: ASME A112.36.2M
 3. Size: Same as connected drainage piping up to 4".

4. Round stainless-steel wall access cover with securing screw and bronze raised head plug.

2.2 FLOOR DRAINS

- A. Approved manufacturers: Zurn, JR Smith, Wade
- B. Coated cast-iron body unless otherwise indicated.
- C. Provide floor drain with deep seal p-trap.

2.3 DOWNSPOUT BOOTS

- A. Approved manufacturers: Zurn, JR Smith, Wade
- B. Nickel bronze body, threaded inlet and decorative face of wall flange and outlet nozzle.

2.4 HOSE BIBBS

- A. Approved manufacturers: Woodford, Zurn, JR Smith
- B. HB2: Angle pattern hose bibb consisting of a brass body, vacuum breaker-backflow preventor with $\frac{3}{4}$ " (inch) male hose thread nozzle, loose tee-handle and $\frac{3}{4}$ " copper water tube inlet.

2.5 WALL HYDRANT

- A. Approved manufacturers: Woodford, Zurn, JR Smith
- B. HB1: Freeze-proof wall hydrant consisting of a brass casting with chrome finish, vacuum breaker-backflow preventor with $\frac{3}{4}$ " (inch) copper water tube inlet. A loose tee key shall be furnished with each wall hydrant.

2.6 TRAP PRIMERS

- A. Provide Trap Guards where allowed by Authority Having Jurisdiction. Waterless inline Trap Guard conforming to ASSE 1072 equal to Recotorseal "Sure Seal" Model SS3009V. Install Trap Guards in the outlet of the floor drain, not in the strainer.

2.7 WATER HAMMER ARRESTERS

- A. Approved manufacturers: Precision Plumbing Products (PPP), Sioux Chief, Zurn
- B. Water hammer arresters shall have sufficient volume of air to dissipate the calculated kinetic energy generated in the piping system. Arresters shall be effective when installed at any angle. Water hammer arresters shall be ANSI/ASSE 1010 2004 certified. Arresters shall be sized and placed according to the manufacturer's instructions.

2.8 THERMOMETERS

- A. Approved manufacturers: Ernst Gage, Weiss Instruments, Weksler
- B. 4-inch mercury type. Temperature range shall be 0°F to 200°F.

2.9 PRESSURE GAGES

- A. Approved manufacturers: Ernst Gage, Weiss Instruments, Weksler
- B. 4-1/2-inch dial, stainless steel and phosphor bronze movement, gauge cock and throttling device. Pressure range shall be 0 psi to 150 psi.
 - 1. The operating point of gauge shall be on middle third of pressure range.

2.10 BALANCING VALVES

- A. Approved Manufacturers: Bell & Gossett, Watts, TACO
- B. Valves shall be designed to allow installing contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with pre-set balance schedule.
- C. Valves shall consist of Lead-Free Brass / stainless steel ball construction with glass and carbon filled TFE seat rings. Valves shall have differential pressure read-out ports across valve seat area. Read-out ports to be fitted with internal EPT inserts/check valves. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves have memory stop feature to allow valves to be closed for service and then reopened to set point without disturbing balance position. All valves shall have calibrated nameplates to assure specific valve settings. Valves shall be designed for positive shut-off. Valves shall be ANSI/NSF-61, Annex G compliant.

2.11 THERMOSTATIC MIXING VALVES

- A. Approved Manufacturers: Leonard, Symmons, Lawler
- B. Valves shall be ANSI/NSF-61, Annex G compliant.
- C. Point of use mixing valves – Valve with bronze body, copper encapsulated thermostat, brass and engineered polymer internals, stainless steel spring, locking temperature adjustment knob (tamper-resistant), integral check valves on inlets, IPS or sweat connections, mounting bracket. Unit shall be ASSE 1070 listed, and 3rd party certified as lead free.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to 4 inch. Use 4 inch for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 100 feet.
- 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 balancing valves in locations where they can easily be adjusted.
- E. Install water-hammer arrestors in water piping according to PDI-WH 201.

- F. Install air vents at high points of water piping.

3.2 ADJUSTING

- A. Set field adjustable flow set points of balancing valves.
- B. Set field adjustable temperature set points of temperature-actuated, water mixing valves.

3.3 PROTECTION

- A. Protect drains during the 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.
- C. Protect materials stored on site from weather and theft. Do not store materials directly on ground.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Evaluate each pressure vacuum breaker and reduced pressure backflow preventer according to authorities having jurisdiction and the device's referenced standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 22 05 15

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Plug valves.
3. Check valves.

B. Related Sections:

1. Section 22 05 03 – Plumbing Pipe, Tube and Fittings
2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
3. Section 22 07 00 - Plumbing Insulation

1.2 REFERENCES

A. ASTM International:

1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
2. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install valves underground when bedding is wet or frozen.

1.8 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer warranty for valves excluding packing.

1.9 EXTRA MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 BALL VALVES

- A. Manufacturers:
 - 1. Apollo Valves, Conbraco Company.
 - 2. Crane Valve, North America.
 - 3. Hammond Valve Model.
 - 4. Jomar Valve
 - 5. Milwaukee Valve Company.

6. NIBCO, Inc. Model.
 7. Stockham Valves & Fittings Model.
 8. Victaulic
- B. 4 inch and Smaller: MSS SP 110, 600 psi WOG, two-piece brass or bronze body, chrome plated brass ball and stem, full port, PTFE seats, blow-out proof stem, solder or threaded ends, lever handle.

2.2 PLUG VALVES

- A. Manufacturers:
1. DeZURIK, Unit of SPX Corp.
 2. Flow Control Equipment, Inc.
 3. Homestead Valve.
- B. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, Teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
- C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, Teflon packing, flanged ends. Furnish wrench operated.

2.3 CHECK VALVES

- A. Spring Loaded Check Valves:
1. Manufacturers:
 - a. Apollo Valve, Conbraco Company
 - b. Crane Valve, North America.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO, Inc.
 - f. Stockham Valves & Fittings.
 - g. Victaulic Company.
 2. 2 inches and Smaller: MSS SP 80, Class 250 bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder, or threaded ends.
 3. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer, or globe style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install 3/4-inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- D. Install valves with clearance for installation of insulation and allowing access.
- E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08.
- F. Refer to Section 22 05 29 for pipe hangers.
- G. Refer to Section 22 07 00 for insulation requirements for valves.
- H. Refer to Section 22 05 03 for piping materials applying to various system types.

3.3 VALVE APPLICATIONS

- A. Valves installed in the domestic water piping system shall be Lead-Free per NSF 61, Annex G or NSF 372 requirements.
- B. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Install globe valves for throttling, bypass, or manual flow control services.
- E. Install spring loaded check valves on discharge of water pumps.
- F. Install ball valves in domestic water systems for shut-off service.
- G. Install globe valves in domestic water systems for throttling service.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.

B. Related Sections:

1. Section 22 05 03 – Plumbing Pipe, Tube and Fittings.
2. Division 03 - Concrete Forming and Accessories.
3. Division 03 - Cast-In-Place Concrete.
4. Division 07 - Joint Protection.
5. Division 09 - Painting and Coating.
6. Division 07 - Requirements for roof flashing installation.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.
- D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved by Factory Mutual Research for Property Conservation.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- F. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 5. UL - Fire Resistance Directory.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: shall comply with ASTM E119, ASTM E814, and/or UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to UL for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

- A. Division 01 - Submittal Procedures.
- B. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 2. Firestopping: Submit data on product characteristics, performance, and limitation criteria.
- C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- D. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
 2. Firestopping: Submit preparation and installation instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10-inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when evaluated in accordance with ASTM E84.
- F. Perform Work in accordance AWS D1.1 for welding hanger and support attachments to building structure.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with 5 years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum 5 years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when the temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Carpenter & Paterson Inc.
 - 2. Creative Systems Inc.
 - 3. Flex-Weld, Inc.
 - 4. Glope Pipe Hanger Products Inc.
 - 5. Michigan Hanger Co.
 - 6. Superior Valve Co.

- B. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized, hot dip galvanized, or electro-galvanized.
 3. Nonmetallic Coatings: Plastic coated or epoxy coated.
 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.
- C. Copper Pipe and Tube Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.
- D. Plumbing Piping - DWV:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 2. Hangers for Pipe Sizes 1-1/2 inches and Larger: Carbon steel, adjustable, clevis.
 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 4. Vertical Support: Steel riser clamp.
 5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 6. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.
- E. Plumbing Piping - Water:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 4 inches: Carbon steel, adjustable, clevis.
 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 4. Vertical Support: Copper-plated, Steel riser clamp.
 5. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 6. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 7. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb./sq. ft sheet lead.
 - 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: 47 mils thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gages at fire resistant elements.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-Fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-Fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic; refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. B-Line Systems.
 - 2. Unistrut Corp.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches in the center.

2.8 FIRESTOPPING

- A. Manufacturers:
 - 1. Dow Corning Corp.

2. Fire Trak Corp.
 3. Hilti Corp.
 4. International Protective Coating Corp.
 5. 3M fire Protection Products.
 6. Specified Technology, Inc.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Intumescent Firestopping: Intumescent putty compound which expands exposure to surface heat gain.
 2. Firestop Pillows: Formed mineral fiber pillows.
- C. Color: As selected from manufacturer's full range of colors.

2.9 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- C. General:
1. Furnish UL listed products or products evaluated by other approved independent testing laboratory.
 2. Select products with rating not less than rating of wall or floor being penetrated.
- D. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Division 01 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing or damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1, ASME B31.5, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69, MSS SP 89.
- B. Where insulated horizontal piping occurs, provide hangers of adequate size to allow for pipe insulation to be run continuously through the hanger assembly.
- C. Support vertical piping and tubing at base and at each floor.
- D. Support horizontal piping as scheduled.
- E. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.
- F. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- G. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.
- H. Install hangers for CAST-IRON SOIL piping with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
1½, 2	5	3/8
3	5	1/2
4, 5	5	5/8

6	5	3/4
8 - 12	5	7/8

1. Install supports for vertical cast-iron soil piping every 15 feet.

I. Install hangers for STEEL piping with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
½ - 1¼	7	3/8
1½	9	3/8
2	10	3/8
3	11	1/2
4	12	5/8
6	12	3/4
8 - 12	12	7/8

1. Install supports for vertical steel piping every 15 feet.

J. Install hangers for COPPER tubing with the following maximum horizontal spacing and minimum rod diameters:

PIPE SIZE (IN.)	HORIZONTAL HANGER SPACING (FT)	ROD DIAMETER (IN.)
½ - 1¼	5	3/8
1½, 2	6	3/8
2½	8	1/2
3, 4, 5	10	1/2
6	10	5/8
8	10	3/4

1. Install supports for vertical copper tubing every 10 feet (3 m).

K. Place hangers within 12 inches of each horizontal elbow.

L. Use hangers with 1-1/2-inch minimum vertical adjustment.

M. Support horizontal cast iron pipe adjacent to each hub.

N. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

- O. Support piping and tubing not listed above per MSS SP-69 and manufacturer's written instructions.
- P. Prime coat exposed steel hangers and supports. Refer to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- Q. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls and floors.
- B. Flashing for roof penetrations shall be provided by the roofing contractor.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36-inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, shower and/or mop sink drain watertight to adjacent materials.

3.7 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel or stainless-steel escutcheons on finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, and other items, requiring firestopping.
- B. Fire Rated Surface:
 - 1. Seal opening at rated floor, wall, partition, ceiling, and/or roof as follows:

- a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allows minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
- C. Non-Rated Surfaces:
1. Seal opening through non-fire rated wall, partition, floor, ceiling, and/or roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allows minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 2. Install wall escutcheons, floor plates or ceiling plates where conduit penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
 4. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, data rooms and. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.9 FIELD QUALITY CONTROL

- A. Division 01 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Pipe markers.
4. Ceiling tacks.
5. Labels.

B. Related Sections:

1. Division 09 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Division 01 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 EXTRA MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two containers of spray-on adhesive.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
- B. Plastic Tags:
 - 1. Laminated three-layer plastic with engraved letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- C. Metal Tags:
 - 1. Aluminum with stamped letters; tag size minimum 1½ inches diameter with finished edge.
- D. Information Tags:
 - 1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- E. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1; "Scheme for the Identification of Piping Systems."
- B. Pipe markers installed above ceiling in return air plenums shall be plenum rated.

C. Plastic Pipe Markers:

1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

D. Plastic Tape Pipe Markers:

1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Plastic Underground Pipe Markers:

1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mils thick, manufactured for direct burial service.

2.4 CEILING TACKS

A. Description: Steel with 3/4-inch diameter color-coded head.

B. Color code as follows:

1. Plumbing valves: Green.

2.5 LABELS

A. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify valves in main and branch piping with tags.

I. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction, and pressure. Install it in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including

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risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- J. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 22 05 53

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets, and accessories.

B. Related Sections:

1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
2. Division 09 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.2 REFERENCES

A. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
4. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
5. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
6. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
7. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
10. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Fire Protection Association:

1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc.:

1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Division: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. LEED Submittal:
 - 1. Product data for credit EQ4.1: For adhesives and sealants, including printed statement of VOC content.

1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 01: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.8 FIELD MEASUREMENTS

- A. Verify all field measurements prior to fabrication.

1.9 WARRANTY

- A. Division 01: Product warranties and product bonds.
- B. Furnish for one year minimum.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
 - 1. CertainTeed.
 - 2. Knauf.
 - 3. Johns Manville.
 - 4. Owens-Corning.
- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
 - 1. Aeroflex. Aerocell.
 - 2. Armacell, LLC. Armaflex.
 - 3. Nomaco. K-flex.

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 850 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:
 - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- B. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1784, one piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 15 mils.
3. Connections: Pressure sensitive color matching vinyl tape.

2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum or stainless-steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.
- E. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- F. Adhesives: Compatible with insulation.
 1. Indoor Vapor Retarder Finish:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.5 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, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 2. calculated per 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Manufacturers:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).

- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. Marathon Industries, Inc.; 225.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. Speedline Corporation; Speedline Vinyl Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).

2.6 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content that meets the requirement of the South Coast Air Quality Management District Rule #1168. VOC limits to be per amendment date 1/7/05.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. Marathon Industries, Inc.; 590.
 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Manufacturers:

- a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. Marathon Industries, Inc.; 501.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Manufacturers:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.
 6. For outdoor aluminum finish, use 60-39 mastic.

2.7 SEALANTS

- A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products - Manufacturers:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg F.
 5. Color: White or gray.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers:

- a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).

2.8 FIELD APPLIED FABRIC – REINFORCING MASH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
1. Manufacturers:
 - a. Vimasco Corporation; Elastafab 894.
- B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
1. Manufacturers:
 - a. Childers Products, Division of ITW; Chil-Glas No. 5.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.
1. Manufacturers:
 - a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

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.

1. Manufacturers:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 SECUREMENTS

A. Bands:

1. Manufacturers:

- a. Childers Products; Bands.
- b. PABCO Metals Corporation; Bands.
- c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.

4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

5. Copper clad annealed steel wire having a minimum 16-gauge thickness.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

a. Manufacturers:

- 1) AGM Industries, Inc.; CWP-1.
- 2) GEMCO; CD.
- 3) Midwest Fasteners, Inc.; CD.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Manufacturers:

- 1) AGM Industries, Inc.; CWP-1.
- 2) GEMCO; Cupped Head Weld Pin.
- 3) Midwest Fasteners, Inc.; Cupped Head.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-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. Manufacturers:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
4. 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.
 - a. Manufacturers:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.
 1. Manufacturers:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC per ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 01: Coordination and project conditions.
- B. Verify piping and or equipment has been evaluated before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Install insulation continuously through all hanger assemblies.

- C. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 07 for penetration of assemblies with fire resistance rating greater than one hour.
- D. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate the entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- E. Glass Fiber Board Insulation
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.
- F. Hot Piping Systems less than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 3. Do not insulate unions and flanges at equipment, but bevel and seal end of insulation at such locations.
- G. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- H. Insulation Terminating Points:

1. Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the control valve.
 2. Condensate Piping: Insulate the entire piping system and components to prevent condensation.
- I. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
 2. Miter joints at elbows.
 3. Seal seams and butt joints with manufacturer’s recommended adhesive.
 4. When application requires multiple layers, apply with joints staggered.
 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- K. Prepare pipe insulation for finish painting. Refer to Division 09.

3.3 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements for firestopping and fire-resistive joint sealers.
- C. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies.

3.4 SCHEDULES

- A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS (inches)
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches and smaller	1.0
		1-1/2 inches and larger	1.5
Domestic Cold Water	P-1 or P-5	1-1/4 inches and smaller	0.5
		1-1/2 inches and larger	1.0

END OF SECTION 22 07 00

SECTION 22 30 10 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 (General Requirements) sections of the Project Manual apply to this Section.
- B. The General Conditions shall be carefully examined before proposals for any work are submitted. Division 22 shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions unless Division 22 sections contain statements more definitive or more restrictive.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Water Heaters
 - 2. Pumps
 - 3. Expansion Tanks
- B. Related Sections include the following:
 - 1. Section 22 05 03 – Plumbing Pipe, Tube and Fittings
 - 2. Section 22 05 23 – General-Duty Valves for Plumbing Piping
 - 3. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
 - 4. Section 22 07 00 – Plumbing Insulation
 - 5. Section 22 42 00 – Plumbing Fixtures

1.3 SUBMITTALS

- A. Submittals shall be in accordance with Section 220500 – Plumbing General.
- B. The Contractor shall submit manufacturer's catalog data for the following:
 - 1. Water Heaters
 - 2. Pumps
 - 3. Expansion Tanks
- C. The Contractor shall submit Operation and Maintenance Data in accordance with Section 220500 for the following:
 - 1. Water Heaters
 - 2. Pumps

PART 2 - PRODUCTS

2.1 WATER HEATERS

- A. General
 - 1. Packaged water heater systems shall be furnished factory wired and UL listed. Final electrical connections shall be provided as indicated in Division 26.
 - 2. Storage tanks shall be insulated so that the maximum heat loss of the tank does not exceed 14 BTUH per square foot of tank surface area or the current ASHRAE 90 standard, whichever is more stringent.
 - 3. Water heater systems shall meet current ASHRAE 90A efficiency requirements.

4. Provide the services of a manufacturer's representative experienced in the installation and operation of this equipment for not less than one workday on-site for installation inspection, startup, and instruction of owner's personnel.

B. Electric Storage Water Heaters

1. The water heater shall have a modulating input rating and recovery capacity as indicated in the drawings. The heater to be completely insulated and jacketed for vertical installation. The jacket shall be a round h. y gauge galvanized steel assembly, primed and pre-painted on both sides with a minimum dry film thickness of 0.70 mills. The jacket shall have a full-length element access panel and a hinged control panel access door for safety. The jacketed tank assembly shall have an accessible drain. The tank shall be factory insulated with a 3-inch-thick high-density non-CFC polyurethane foam to meet the minimum stand-by loss requirements of the latest edition of ASHRAE 90.1 Energy Efficiency Standards.
2. The tank shall be of standard construction in accordance with ASME Boiler and Pressure Vessel Code requirements and shall be stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. The tank shall be standard with a 150-psi working pressure for 5 through 50-gallon models and 125 psi working pressure for 65 through 120-gallon models. The tank shall be glass lined with vitreous glass enamel and fired at 1600°F to ensure a molecular fusing of glass and steel. A combined magnesium tank saver anode with a powered anode shall be installed in the tank for corrosion protection. A handhole clean-out shall be standard on all models to allow inspection and cleaning of the vessel. Tank inlet and outlet water connections shall be 1-1/2" NPT.
3. The immersion heating elements shall be low watt density with an incoloy sheath for long life. The heating elements shall mount in individual screw-in tank flanges. In accordance with U.L. requirements, water heaters with a current draw of more than 120 amps shall be equipped with internal fusing.
4. All field electrical wiring connections to the water heater shall be made to a main terminal block. All internal wiring shall be made to solderless terminal lug wiring connections. Wiring to be color coded for ease of servicing. An ASME rated temperature and pressure relief valve shall be provided with the water heater. The water heater shall be factory assembled, wired, and evaluated. The entire water heater shall be U.L. Listed and provided with a 3-year limited warranty on the tank and a 1-year limited warranty on parts.
5. Immersion Thermostats and Contactors – Heating elements shall be switched by a magnetic contactor(s) operated by a fused 120-volt control circuit with an advanced electronic control. The electronic control shall have an LCD readout which will display operational and diagnostic information. Standard features include Low Water Cutoff, Element Sensing and Night Setback. The control shall be capable of supplying 180°F water. The control circuit shall use a built-in transformer to reduce line voltage to 120 volts for operation of the control circuit components. The control circuit shall include a manual reset safety hi-limit control to prevent overheating in the event of a component failure.
6. Approved manufacturers: Lochinvar, A.O. Smith, Bradford White.

2.2 PUMPS

- A. Hot Water Recirculation Pumps shall have capacities and motor HP as noted on the drawings. The pump shall be of all bronze construction and shall be furnished with

companion flanges. The pump assembly shall be provided with isolation valves, check valve, two evaluate plugs for insertion of pressure gauges and temperature sensor.

1. Approved Manufacturers: Bell & Gossett, Taco, Grundfos

2.3 EXPANSION TANK

- A. Pre-pressurized diaphragm type steel expansion tank. Tank shall conform to ASME Section VIII construction for 125 psig, (200 psig WOG), tank shall have rigid polypropylene lining for corrosion control, butyl rubber diaphragm. Provide pressure gauge on system connection piping.
- B. Thermal expansion tank shall be installed to absorb expansion from hot water generator and storage tanks under no-flow or low-flow conditions. System connection shall not be located upstream of check valves or regulating valves or downstream of mixing valves or in a manner that shall negate this purpose.
- C. Thermal expansion tank pressurization shall be field charged to match the domestic water system pressure when pumps are energized and when water temperature in storage tank is at 40 to 80°F temperature. Acceptance volume shall be based upon the difference between system pressure and temperature relief valve pressure.
- D. Approved Manufacturers: Amtrol, Bell & Gossett, Wessels

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment, piping and accessories shall be installed in strict accordance with the manufacturer's requirements.
- B. Drain and thermal purge from all pumps shall be extended to within 4 inches of floor drain.
- C. Water heater relief valves shall be piped as indicated or to a point which will not cause personal injury or property damage and shall be readily observable by the building occupants.
- D. Water heaters or storage tanks located in areas where leakage of the tanks or connection will cause damage shall be provided with galvanized steel pan.
- E. Provide isolation valves for all equipment and accessories.
- F. Unions shall be provided adjacent to all equipment or wherever necessary to facilitate the removal of equipment for repair or replacement. Unions for copper tubing up to and including 2-inch diameter shall be brass ground joint with socket ends for solder. Unions for copper tubing 2-1/2 inches in diameter and over shall be standard brass flanges and so stamped. No lip type unions or long screws will be permitted. The contractor shall furnish and install all structural steel angles, channels, etc. necessary to properly support all fixtures and equipment to the satisfaction of the Professional.
- G. Furnish and install isolation valves at the cold water and hot water supply tapings and an AGA/ASME pressure and temperature relief valve for each water heater.
- H. The drawings are diagrammatic in showing plumbing equipment layout. Variations in differing manufacturer's piping arrangements and physical equipment size require careful layout by the Contractor. The Contractor shall coordinate his layout to provide adequate

clearances to allow for maintenance and inspection. Equipment support shall not obstruct floor drains or utility trench access and piping shall be installed to allow sufficient vertical clearance above treatment tanks.

END OF SECTION 22 30 10

SECTION 22 42 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 (General Requirements) sections of the Project Manual apply to this Section.
- B. The General Conditions shall be carefully examined before proposals for any work are submitted. Division 22 shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions unless Division 22 sections contain statements more definitive or more restrictive.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Water Closets
 - 2. Urinals
 - 3. Lavatories
 - 4. Sinks
 - 5. Electric Water Coolers
- B. Related Sections include the following:
 - 1. Section 22 05 03 – Plumbing Pipe, Tube and Fittings
 - 2. Section 22 05 23 – General-Duty Valves for Plumbing Piping
 - 3. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
 - 4. Section 22 07 00 – Plumbing Insulation

1.3 SUBMITTALS

- A. Submittals shall be in accordance with Section 220500 – Plumbing General.
- B. The Contractor shall submit manufacturer's catalog data for the following:
 - 1. Water Closets
 - 2. Urinals
 - 3. Lavatories
 - 4. Sinks
 - 5. Electric Water Coolers
 - 6. Flush Valves
 - 7. Toilet Seats
 - 8. Fixture Carriers
 - 9. Faucets and Mixing Valves
- C. The Contractor shall submit Operation and Maintenance Data in accordance with Section 220500 for the following:
 - 1. Electric Water Coolers
 - 2. Flush Valves
 - 3. Faucets and Mixing Valves

PART 2 - PRODUCTS

2.1 GENERAL

- A. All fixtures shall be furnished complete with traps, faucets, waste, supplies with stops, etc., as required. All exposed metal parts shall be chromium plated.
- B. Fixtures and equipment shall be those of reputable manufacturers and shall be new and the best of their respective kinds.
- C. All fixtures and equipment of similar types shall be of the same manufacturer unless indicated otherwise on the drawings or specified herein.
- D. Fixtures shall be mounted at mounting heights as indicated.
- E. If fixtures and equipment indicated in the Contract Documents are not currently manufactured, the manufacturer's current equivalent to the indicated fixtures and equipment shall be provided at no additional cost, subject to review and acceptance by the Professional.

2.2 PLUMBING FIXTURES

- A. See Plumbing Fixture Schedule on Drawings for Fixture Specification. Manufacturers shall be equal to those listed on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures and equipment shall be installed in a neat and skillful manner and in accordance with the manufacturer's recommendations. The quality of installation shall be subject to the approval of the Professional.
- B. All wall mounted lavatories, chair carriers and supports shall be suitable to the type of construction wherein they are located. Urinals shall be supported by chair carriers.
- C. All fixtures and equipment must be protected against damage during the progress of construction. Upon completion of construction, all fixtures and equipment must be thoroughly cleaned and left in perfect working order. All piping and accessories having polished, plated, or finished surfaces shall be protected to prevent scarring or other damage and protect the finish against damage.
- D. Provide isolation valves for all fixtures, equipment, and accessories.
- E. All fixture supplies and waste lines shall be run to wall unless construction requires, they be run to floor. All supplies through walls shall be provided with angle stops. All supplies through floors shall be provided with straight stops. Unions shall be provided adjacent to all equipment or wherever necessary to facilitate the removal of equipment for repair or replacement. Unions for copper tubing up to and including 2-inch diameter shall be brass ground joint with socket ends for solder. Unions for copper tubing 2-1/2 inches in diameter and over shall be standard brass flanges and so stamped. No lip type unions or long screws will be permitted. The contractor shall furnish and install all structural steel angles, channels, etc. necessary to properly support all fixtures and equipment to the satisfaction of the Professional.
- F. Drain piping from all backflow preventers, relief valves and vents, drain down connections, etc. shall be extended to within 4 inches of a floor drain unless otherwise directed.

- G. Mop receptor drains shall be sized for the outlet pipe size shown on drawings and shall be equipped with P-traps. The Contractor shall be responsible for proper height setting and leveling of drains.
- H. Water closet floor flanges shall be cast ironed, screwed, or caulked, not less than ¼ inch thick; not less than 2 inches caulking depth. Bolted with approved gasket between closet bowl and flange. Closet screws shall be of brass. The use of commercial putty or plaster for setting closet bowls is prohibited.
- I. Apply a bead of waterproof caulking around the edge of surface mounted plumbing fixture to mask any irregularities between the fixture and wall finish. The color of caulk shall match the fixture color.

3.2 MOUNTING HEIGHTS

- A. Plumbing fixture mounting heights shall be as indicated on the drawings. Mounting heights for barrier free fixtures shall meet the requirements of the ADA Accessibility guidelines. These guidelines shall apply unless superseded by more stringent State or Local requirements.

END OF SECTION 22 42 00

Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED PROVISIONS

- a. The requirements of the general conditions and of Division 01 apply to that portion of the work specified in this section.
- b. These specifications and the accompanying drawings shall include the furnishing of all labor, tools, materials, fixtures, transportation, appurtenances, and service necessary and incidental to the installation of a complete and operative system as indicated and intended on the Drawings and as herein specified.
- c. Contractor shall coordinate the work and equipment of this division with the work and equipment specified elsewhere to assure a complete and satisfactory installation. Work such as excavation, backfill, concrete, flashing, etc., which is required by the work of this Division of the Specifications, shall be provided by this Division unless otherwise indicated.
- d. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

1.2 DESCRIPTION OF THE WORK:

- a. Work included under this Division includes installation of a new cooling and heating system and associated electrical system and controls system. The systems shall be installed complete, with boilers, piping, chiller, pumps, and auxiliaries as hereinafter called for. Miscellaneous items including conduits, concrete slab, etc., are to be provided as indicated.
- b. It shall be the responsibility of the Contractor to provide a complete operating system according to the true intent and meaning of the plans and specifications and all pipe, controls, and equipment, etc.

1.3 DEFINITION

- a. The word "Contractor" as used in this Section of the Specifications refers to the HVAC Contractor unless specifically noted otherwise. The word "provide" means furnish, fabricate, complete, install, erect, including labor and incidental materials, necessary to complete in place and ready for operation or use the items referred to or described herein, and/or as shown or referred to on the Contract Drawings.

1.4 HVAC CONTRACTOR'S QUALIFICATIONS

- a. It is assumed that the contractor has had sufficient general knowledge and experience to anticipate the needs for a construction of this nature. The contractor shall furnish all items required to complete the construction in accordance with reasonable interpretation of the intent of the Drawings and Specifications. Any minor items required by the Code, law or regulations shall be provided whether specified or specifically shown.

- b. All work must be done by first class and experienced mechanics properly supervised, and it is understood that the Engineer has the right to stop any work that is not being properly done and has the right to demand that any incompetent worker be removed from the job and a competent worker be substituted therefor.
- c. All work must be done in strict accordance with the standards of AME, ASHRAE and the building laws of all characters in force in the locality where the apparatus is being installed. All work must also be in accordance with rules and regulations of the National Board of Fire Underwriters.

1.5 DUTIES OF CONTRACTOR

- a. Contractor is responsible for familiarizing himself with the details of the construction of the building. Work under these specifications installed improperly or which requires changing due to improper reading or interpretation of building plans shall be corrected and changed as directed by Engineer without additional cost to the Owner.
- b. Contractor shall leave the premises in a clean and orderly manner upon completion of work and shall remove from premises all debris that has accumulated during the progress of the work. The HVAC Contractor shall have the permanent HVAC systems in sufficient readiness to furnish temporary climatic control at the time the building is enclosed. The HVAC systems control shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishers of the building. A building shall be considered enclosed when it has windows installed and when doorways and other openings have protection which will provide reasonable climatic control. The appropriate climatic condition shall be jointly determined by the Contractor and the Architect. Use of the equipment in this manner shall in no way affect the warranty requirements of the Contractor.

1.6 CODES, RULES, PERMITS AND FEES

- a. The contractor shall give all necessary notices, obtain all permits and pay all government sales taxes, fees and other costs including utility connections or extension, in connection with his work; file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required certificates for inspection for his work and deliver same to the Architect before request for acceptance and final payment for the work.
- b. The contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, ordinances, rules, and regulations as required to complete the project in accordance with the intent of the drawings.
- c. All materials furnished, and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of all governmental departments having authority.

1.7 SURVEYS AND MEASUREMENTS

- a. The contractor shall base all measurements, both horizontal and vertical, on established benchmarks. All work shall agree with these established lines and levels.

Verify all measurements at the site and check correctness of same as related to the work.

- b. Should the contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and Specifications, he shall notify the Architect and shall not proceed with his work until he has received instructions from the Architect.

1.8 PLANS

- a. Except where dimensions are shown, mechanical plans are diagrammatic; see Architectural drawings for building dimensions and locations of windows, doors, ceiling diffusers, lights, etc. The plans are not intended to show each and every fitting, valve, pipe or pipe hanger, or a complete detail of all the work to be done but are for the purpose of illustrating the type of system, pipe and duct sizes, etc. and special conditions considered necessary for the experienced mechanic to take off his material and lay out his work. The contractor shall be responsible for taking such measurements as may be necessary at the job and adapting his work to the local conditions.

1.9 DRAWINGS AND SPECIFICATIONS

- a. Plans are diagrammatic, and it sometimes occurs that conditions exist in buildings which require certain changes in drawings and specifications. In event that such changes are necessary, the same are to be made by Contractor without expense to the Owner, provided however, that such changes, do not require furnishing more material or performing more labor than the true intent of the drawings and specifications demand.
- b. It is understood that while the drawings are to be followed as closely as circumstances will permit, the Contractor is held responsible for the installation of the system according to the true intent and meaning of the drawings. Anything not entirely clear on the drawings or in the specifications will be fully explained if application is made to the Engineer. Should however, conditions arise where in the judgment of the Contractor certain changes would be advisable. The contractor will communicate with the Engineer and secure approval of the changes before going ahead with the work.
- c. The electrical and mechanical systems for this job have been designed based on the mechanical equipment listed or data given herein or on the drawings. It shall be the responsibility of the Contractor to determine that the electrical service outlets, wiring, conduit, and all overcurrent protective and safety devices furnished are adequate to meet Code Requirements for the equipment which he proposes to use. Changes required in the electrical system to accommodate the proposed mechanical equipment shall be worked out and the details submitted for approval. The cost of making the necessary changes to the electrical system shall be the responsibility of the Contractor.

1.10 SHOP DRAWINGS

- a. Refer to Division 01.
- b. All items submitted to the Architect for review should bear a stamp or notation indicating contractor's prior review and approval.

- c. Any Electrical or other changes required by substituted equipment to be made at no change in contract price.
- d. Submit manufacturer's certified performance data for all equipment.
- e. Coordinate installation drawings with other parts of the work, whether specified in this Division or other Divisions.
- f. Approval of shop drawings by the Engineer shall not relieve the Contractor from his obligation to provide equipment, control, and operation to the true intent of plans and specifications.
- g. The Contractor shall submit to the Engineer, within ten (10) days after approval of bids by the owner, a list indicating the manufacturer of all equipment and materials which he proposes to use. After that date, no substitution will be approved, and all items shall be as specified.

1.11 COORDINATION DRAWINGS

- a. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 2. Roof framing and support members relative to duct penetrations.
 - 3. Ceiling suspension assembly members.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.12 SCAFFOLDING, RIGGING, HOISTING:

- a. This contractor shall furnish all scaffolding rigging, hoisting, and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.13 FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS:

- a. Contractor shall furnish and install all necessary foundations, supports, pads, bases, and piers required for all air conditioning equipment, piping, pumps, tanks, compressors, and for all other equipment furnished under this contract.

1.14 SLEEVES AND OPENINGS:

- a. Contractor must have an experienced mechanic on the job before concrete slab floors or concrete masonry walls are poured or built into place, whose duty it shall be to locate exact positions of all holes necessary for future installation of his pipe work, ducts, or equipment. Where pipes pass through concrete or masonry walls or floors, steel pipe sleeves shall be furnished. These shall be the same length as wall thickness and shall extend 1/2" above finished floors. Pipe sleeves in equipment room floors shall extend 3" above refinished floor. Pipe sleeves in equipment room floors shall extend 3" above finished floor. Sleeves shall be placed in position by this Contractor.

- b. This Contractor shall arrange for proper openings in the building to admit his equipment. If it becomes necessary to cut any portion of the building to admit his equipment, portions cut must be restored to their former condition by this Contractor.
- c. This Contractor will provide duct openings or chases in masonry or concrete; however, it is this Contractor's responsibility to advise exact dimensions, shape and locations of openings required in sufficient time for the Contractor to make necessary provisions. This Contractor shall be responsible for correct size and location of each opening for his equipment through these openings.
- d. Wall openings that require a fire or smoke damper shall be made as nearly possible to the damper or duct size so that an angle frame can close the opening entirely.
- e. Where pipes or ducts penetrate floors or partitions which are fire or smoke barriers, the integrity of the barrier shall not be compromised by such penetration.

1.15 CUTTING AND PATCHING:

- a. The Contractor shall do all cutting, fitting, and patching as required to install piping and equipment except openings through the roof shall be provided by the General Contractor. Patching shall be done by mechanics skilled in the various trades and the work shall match the existing work.
- b. All exposed openings in walls and floors for piping shall be core drilled. Cutting holes by hand will not be allowed.
- c. Provide all required protection including but not limited to, welding blankets, dust covers, shoring bracing and supports to maintain structural integrity, safety, and cleanliness of the work.

1.16 EXCAVATION AND BACKFILLING:

- a. All excavation and backfilling, puddling and tamping required to properly install work under this contract shall be done by this Contractor.
- b. Trenches shall be on an even grade and firmly packed to form a solid foundation for laying piping. The Contractor is cautioned to comply with the North Carolina Department of Labor requirements concerning shoring for excavations.
- c. Backfill shall be clear of rocks and trash. Backfilling shall be water tamped to provide firm footing for finish work and shall be maintained at proper level for duration of the Contract. No backfilling shall be done until the work to be covered has been inspected. Excessive excavation material shall be deposited on site and leveled as directed by the engineer.

1.17 POURED IN PLACE CONCRETE WORK:

- a. Furnish and install all concrete work required for the construction of anchors, guide bases and elsewhere as indicated on the Drawings. Refer to appropriate Section in Division 3 for specification requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- a. Provide equipment complete with all components and accessories necessary for its satisfactory operation.
- b. Listing of a manufacturer's name in this Division does not infer conformity to all requirements of the Contract Documents, nor waive requirements thereof.

PART 3 - EXECUTION

3.1 BELT DRIVES

- a. V-belt drives shall be rated at not less than 200% of nominal motor horsepower.
- b. Motor sheaves shall be fixed pitch type.
- c. Scheduled fan static pressures are estimated. Provide one extra drive per device as required to allow adjustment to deliver scheduled air quantities against actual system resistance.
- d. Provide guards for all belt drives not enclosed within equipment housings. Provide openings in guard at driving and driven sheaves for use of revolution counter.

3.2 MAINTENANCE AND OPERATING INSTRUCTIONS

- a. Upon completion of all work, the Contractor shall furnish a complete set of operating instructions for all equipment. Such instructions shall be diagrammatic in form on heavy white paper, suitably framed, protected with glass, and hung where directed by the owner. A preliminary draft of the instruction sheets shall be submitted to the engineer for approval before making same.
- b. Manufacturer's instruction books, card, etc., (to each individual piece of equipment furnished under this contract) shall be furnished to the owner. These shall contain instructions for the operation and maintenance of all equipment. Where such is not furnished by the manufacturer, the contractor shall give written instructions to the owner for the maintenance of the equipment involved.

3.3 DUCTS, PLENUM, ETC.

- a. As indicated in the drawings, provide a system of ducts for supplying returning and exhausting air from various spaces. All details of the ductwork are not indicated, and the necessary bends, offsets and transformations must be furnished whether shown or not.
- b. All sheet metal ducts, casing, plenums, etc., of sizes indicated, shall be constructed from prime galvanized sheet steel, and shall be in accordance with or equal to standards set forth in latest issue of SMACNA low velocity duct manual for gauges of materials, (2" pressure), workmanship, method of fabrication and erection.
- c. All uninsulated panels of ducts over twelve inches (12") wide shall be cross broken, except on plenums, which shall be braced with angle iron as required to prevent breathing.

- d. All ductworks must present a smooth interior and joints must be airtight. Where there is evidence of undue leakage at the joints in low pressure ducts, they shall be sealed with cement like Foster 30-02.
- e. Depending upon space requirements, round or square elbows may be used as required or at the Contractors option in low velocity ducts. All elbows shall be constructed for minimum pressure drop. All elbows with an inside radius less than 3/4 the width of the duct must be fitted with multiple double thickness turning vanes.
- f. No transformations or offsets shall be made with a slope greater than (7 to 1), space conditions permitting.
- g. Where indicated on drawings, ductwork is to be lined with flexible fiberglass acoustics material weighing not less than 1 1/2 lb. per cubic foot and having a flame spread classification of not more than twenty-five (25) as listed under Underwriters Laboratories. Liner shall be applied according to SMACNA duct liner standard. Thickness shall be as indicated on the drawings. Duct sizes on plan are inside clear sizes, increase the actual sheet metal size accordingly in sizing the duct.
- h. The lining shall be secured to the ductwork with a suitable adhesive and with mechanical fasteners center. The liner shall be cut such that adjacent sections of insulation butt together and are sealed with Foster 30-02 joints.
- i. All duct connections to and from all centrifugal fans or cabinets containing fans, shall be made with fabric equal to "Ventfab" as made by Ventfabrics, Inc., not less than four inches (4") long secured by peripheral iron straps holding fabric in galvanized iron, except as otherwise noted.
- j. Vertical ducts shall be supported by means of an angle iron frame riveted to the ductwork on at least two (2) sides. Horizontal runs of ductwork shall be supported on not more than 8'-0" centers as required.
- k. Manual volume and splitter dampers shall be furnished and installed where shown and where necessary for proper regulation of the air distribution. A quadrant and set screw equal to "Ventlock" #641 shall be installed for all dampers which are concealed above plaster or gypsum board ceilings, or behind the masonry construction, furnish and install concealed regulators ("Ventlock" #666) with chrome cover plate.
- l. All ductworks shall operate without chatter and vibration and shall be free from pulsations.
- m. See section 233113 for metal ductwork requirements.

3.4 ACCESS DOORS OR PANELS

- a. Provide duct access doors of approved construction at any apparatus requiring service and inspection. Doors shall suit finish in which installed.
- b. Access doors in rated walls or assemblies shall be rated as required to maintain the rating of assembly. Rated access doors shall bear U.L. Label.

3.5 CLEANING DUCT SYSTEM

- a. Upon complete installation of ducts, clean the entire system of rubbish, plaster, dirt, etc., before installing any outlets. After installation of outlets and connections to fans are made, blow out entire systems with all control devices wide open.

3.6 ITEMS OF ELECTRICAL EQUIPMENT

- a. All electrical work shall be done by properly licensed electrical mechanics in accordance with Division 26 of the specifications under supervision of a licensed Electrical Contractor as approved by the Architect.
- b. The Electrical Contractor shall provide all power wiring to the motor starter and/or disconnect switch and from starter/disconnect switch to motor. The Mechanical Contractor shall provide all control wiring, low voltage, or line voltage, as required for the operation of all mechanical equipment. All control devices such as motor starters, thermostats, switches, etc. shall be provided by the Mechanical Contractor.
- c. All motor starters shall be provided with a "hand-off-auto" switch on the starter cover.
- d. All items of mechanical equipment electrically operated shall be in complete accordance with the electrical division of the specifications. Mechanical equipment, other than individually mounted motors, shall be factory prewired so that it will only be necessary to bring connections to a single set of terminals.
- e. Mechanical equipment electrical components shall all be bonded together and connected to the electrical system ground.
- f. All mechanical equipment and electrical components shall be U.L. listed and labeled.

3.7 WARRANTY AND SERVICE

- a. Upon completion of all work, the contractor shall check the system out so that all motor bearings are greased as required and have all systems balanced. He shall be responsible for original service, for starting the system up, and providing one set of replacement filters after final acceptance.
- b. All equipment shall carry a full one - year warranty with a five - year warranty on the cooling cycle on all packaged-type equipment in accordance with Division 01 of the specifications.

3.8 INSPECTION AND ACCEPTANCE TEST

- a. The project will be checked periodically as construction progresses. The contractor shall be responsible for notifying the Engineer at least 48 hours in advance when any work to be covered up is ready for inspection. No work will be covered up until approved by the Engineer.
- b. Upon completion of erection of all equipment and work specified herein and shown approved shop drawings, and at the time designated by the engineer, the contractor shall start all apparatus, making necessary tests as directed and as specified herein, and adjust of all parts of all equipment before acceptance of equipment by the owner.

The contractor must demonstrate to the owner, by performance, that all equipment operates as specified and meets the guarantee called for.

- c. Tests shall include satisfactory evidence that all systems operate as called for on the drawings, and that all pieces of equipment operate at specified ratings under specified operating conditions.
- d. The contractor shall furnish all fuel and power required for these purposes and provide the proper and necessary help required to operate the system while tests are being made.
- e. All drainage piping shall be evaluated by filling it with water to a point 10' above the underground drains or to point of discharge to grade and let stand thus filled for 3 hours.
- f. Tests on all pipework shall be subject to the inspection of the Engineer. He shall be given 24 hours' notice when a section pipe is to be evaluated and the test shall not be removed until permission is given by the Engineer.

3.9 AS BUILT DRAWINGS

- a. This contractor shall always keep on the job, a clean set of contract drawings in blueprint form. As the job progresses, all deviations from the arrangements, piping runs, equipment locations, etc., shown on the bid prints shall be marked on this set with red ink. These prints shall not be used for any other purpose than to be marked up as "As-Built" Drawings.

3.10 OWNER TRAINING

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain the equipment listed below:
 - 1. DDC Control Systems
 - 2. Air Handlers
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of equipment installed and training requirements indicated. Provide the extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide not less than the number of days of training indicated below.
 - 1) DDC Control Systems - 2 days (16 hours)
 - 2) Rooftop Units - 1 day (8 hours)
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before the end of the warranty period.
- C. Training Schedule:
 - 1. Schedule training with Owner 20 business days before expected Final Acceptance.

2. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions.
 3. Provide staggered training schedule as requested by Owner.
- D. Training Attendee List and Sign-in Sheet:
1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
 2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and at least six blank spaces to add additional attendees.
 3. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
 4. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.
- E. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.
 2. Hard-copy materials shall be organized in a three-ring binder with a table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 3. In addition to hard-copy materials included in the training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.
- F. Organization of Training Sessions:
1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
- G. Training Outline:
1. Submit training outline for Owner review at least 10 business days before scheduling training.
 2. The outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.
- H. On-Site Training:
1. The owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
 2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
 3. Provide as much of training located on-site as deemed feasible and practical by Owner.
 4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with firsthand review of operation, calibration, and service requirements.
 5. Operator workstation provided with DDC system shall be used in training. If the operator workstation is not indicated, provide a temporary workstation to convey training content.
- I. Training Content:
1. Basic operation of each system.

2. Understanding each unique product type installed including performance and service requirements for each.
3. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.

END OF SECTION 23 05 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 polyphase, 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 requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

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 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined *10 CFR Part 431* published by the US Department of Energy
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. 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.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and evaluated to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 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.
 - 3. Capacitors start, inductor run.
 - 4. Capacitor starts, capacitor runs.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, 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.

2.6 VARIABLE FREQUENCY DRIVES

- A. Scope
 - 1. This section provides requirements for AC inverter type adjustable frequency, variable speed drives or herein identified as AC drives for use with (NEMA B, NEMA A, NEMA C, NEMA E, synchronous) design AC motors.
 - 2. All cabling from VFDs feeding associated equipment shall consist of 3-phase, grounded, copper tape spiral shield, galvanized steel interlocked armor cable.
- B. Manufacturers
 - 1. All VFD's in project shall be by the same manufacturer. This shall include all pumps and air handler fans, where indicated on the plans.
- C. Regulatory Requirements
 - 1. UL listed.
 - 2. EN Standard CE marked for the following:
 - Low Voltage Directive (73/23/EEC)
 - EN50178
 - EMC Directive (89/336/EEC)
 - EN61800-3 Adjustable Speed electrical power drive systems Part 3
 - 3. Designed, constructed, and evaluated in accordance with NEMA, ICS, NFPA and IEC standards.
- D. Environmental Requirements
 - 1. The AC drive construction ½ hp to 5 hp 230V and 1 hp to 7.5 hp 480V shall be IP20/open according to Standard EN50178. 7.5 hp to 10 hp 230V and 10 hp to 20 hp 480V shall be Type 1. Both are designed to operate as Pollution degree 2 conforming to IEC 664-1, EN50718 and NEMA ICS-1. Drives above 20 hp 480V and 15 hp 230V shall meet Type 1 Pollution degree 3 according to IEC 664-1, EN50718 and NEMA ICS-1.
 - 2. The AC drive will be designed to operate at an ambient temperature from 0 to 40 degrees C (32 to 104 degrees F).
 - 3. The storage temperature range shall be -25 to 70 degrees C.
 - 4. The maximum relative humidity shall be 95% at 40 degrees C, non-condensing.

5. The AC drive will be rated to operate at altitudes less than or equal to 1000m (3300 ft).
6. The AC drive will meet the IEC 68-2-6-vibration specification.
7. The AC drive shall be designed and constructed to be of finger safe construction with enclosure open to operator access according to IP20 standards.

E. Related Document

1. Division 26 – Electrical

F. Equipment

1. General Description

- a. The AC drive shall utilize soft switching technology and voltage vector control.
- b. The AC drive shall have the Hand/Off/Auto function.
- c. The AC drive shall be provided with AC line reactors and DC chokes.
- d. The AC drive shall have a VFD/bypass system design that is serviceable while operating in bypass mode. This includes a drive disconnect to ensure service personnel safety, a 2-contactor bypass for full speed operation, and an isolation barrier to ensure service personnel safety and repair of the drive while operating in full speed bypass mode. Bypass shall have a separate integral disconnect.
- e. Each AC drive shall have voltage/single phase protection of the drive and bypass system to ensure continued operation after utility power failures. Drive protection modules shall be ATC Diversified Electronics SLU-100-ASA 0315PB or equivalent. Protection modules shall monitor incoming 480V 3-phase power and shall interrupt 120V control circuit. Install modules in drive cabinet.
- f. The AC drive shall have common control in both drive and bypass modes.
- g. Each AC drive shall have M.O.V. lightning protection.
- h. The AC drive shall have safety interlocks for all modes of operation.
- i. A manufacturer's warranty shall be provided on all materials and workmanship of no less than 1 year from the date of start-up or 18 months from date of shipment.

2. Ratings

- a. The AC drive shall be designed to operate from an input voltage of 208/230 +/-15% VAC or 400/460 +/-15% VAC.
- b. The AC drive shall operate from an input voltage frequency range from 47.5 to 63 Hz.
- c. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
- d. The efficiency of the AC drive at 100% speed and load shall not be less than 96%.

- e. The constant torque overtorque capacity will be 150% for 1 minute (The variable torque over torque capacity will be 110% for 1 minute).
- f. The output switching frequency of the drive will be randomly modulated and selectable at 2 kHz, 4 kHz, 12 kHz, or 16 kHz depending on drive rating for low noise operation.
- g. The output frequency shall be from 0.1 to 500 Hz (selectable at 50 Hz, 60 Hz, 200 Hz, 500 Hz).
- h. The AC drive will be able to provide rated motor torque at 0.5 Hz in a Sensorless Flux Vector mode using a standard motor and no tachometer feedback.

3. Protection

- a. Upon power-up, the AC drive shall automatically evaluate for valid operation of memory, option module, loss of analog reference input, loss of communication, (dynamic brake failure), DC to DC power supply, control power, and the pre-charge circuit.
- b. The AC drive shall be protected against short circuits between output phases; between output phases and ground; on the control terminal outputs; and the internal supplies. The logic and analog outputs shall also be optically isolated.
- c. The AC drive shall have a minimum power loss ride-through of 200 msec. The AC drive shall have the user-defined option of frequency fold-back to increase the duration of the power loss ride-through.
- d. The AC drive shall have a selectable ride through function which will allow the logic to maintain control for a minimum of one second without faulting.
- e. For a fault condition other than ground fault, short circuit or internal fault, an auto restart function will provide restart.
- f. The deceleration mode of the AC drive shall be programmable for normal and faulty conditions. The stop modes shall include free-wheel stop, fast stop, and DC injection braking.
- g. A synchronized restart shall be provided that will catch a spinning motor by sensing the motor frequency and rotational direction and synchronize the AC drive's output prior to restarting.
- h. Upon loss of the analog process follower reference signal, the AC drive shall fault and/or operate at a user defined speed set between software programmed low speed and high-speed settings.
- i. The AC drive shall have solid state protection that is UL listed and meets UL 508C as a Class 20 overload protection and meets IEC 947. The adjustment shall be from 0.45 to 1.05 percent of the current output of the AC drive.
- j. The AC drive shall have a thermal switch with a user selectable pre-alarm that will provide a minimum of 60 seconds delay before over temperature fault.

4. Operator Interface

- a. The full English operator interface terminal will offer the modification of AC drive adjustments via a touch keypad. All electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics will be shown.
- b. The AC drive keyboard will announce horsepower and voltage.
- c. The display shall be capable to be configured to display multiple parameters with numeric data that is selectable and scalable by the operator. A user defined display value proportional to output frequency shall be available. As a minimum the display values shall consist of speed reference, output frequency, output current, motor torque, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, motor speed and output power.

G. Execution

1. Installation

- a. The installation shall be in compliance with the manufacturer's instructions, drawings, and recommendations. The AC drive manufacturer shall provide a factory certified technical representative to supervise the contractor's installation, testing and start-up of the AC drive(s).
- b. The contractor shall assume the responsibility for coordinating the purchased equipment with the motor served and with the automatic temperature control system, paying specific attention to the signal sent and received, the ground source and the required speed range.
- c. The manufacturer shall provide start-up of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair are not acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.
- d. The VFD shall be mounted with operator interface between 4'-6" and 5'-6" above finished floor for visibility and accessibility.

H. Training

1. An on-site training session of (4) hours' duration shall be provided by a representative of the AC drive manufacturer and shall be included in the base bid for the project.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 29 - HANGERS AND SUPPORTS 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel 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 include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 5. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

- C. Design seismic-restraint hangers and support for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.", AWS D1.3, "Structural Welding Code--Sheet Steel.", AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code-Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code : Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Material: Carbon Steel
- C. Coating: Galvanized, Hot dipped galvanized
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation inserts encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- 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 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Base: Plastic.
 - 2. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 3. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Bases: One or more plastics.
 - 2. Vertical Members: Two or more protective-coated-steel channels.
 - 3. Horizontal Member: Protective-coated-steel channel.
 - 4. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, 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 APPLICATIONS

- A. Specific hanger and support requirements are specified 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 padded hangers for piping that is subject to scratching.
- F. 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 non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. 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.
 - 15. 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 and with U-bolt to retain pipe.
 - 16. 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.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. 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 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. 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 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: 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. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: 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.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

- N. Use mechanical-expansion anchors instead of building attachments that were required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel 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 building structure.
- B. 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 above for individual pipe hangers.
 - 2. Field fabricates from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- 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 hangers 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 the manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary 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 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 so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
 - 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 according to ASME B31.1 for power piping and 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 inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment support.

3.4 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 cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 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 undercutting or overlapping.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 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 2".

3.6 PAINTING

- A. Touch Up: 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. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.

1.2 SUBMITTAL

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment (Note: Plastic Labels utilized in a return air plenum shall be listed and approved for use in a return air plenum):
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Red.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 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-fourths 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), plus the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Red.

- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. 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-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. (Note: Plastic Labels utilized in a return air plenum shall be listed and approved for use in a return air plenum):
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, and as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond 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.

2.5 CEILING DOT

- A. Provide color coded ceiling dot where HVAC isolation valves & equipment are located above. Conform to owner color standard.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09.
- B. 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. Pipe Label Color Schedule:
 - 1. Refrigerant Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 2. Drain Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; and shutoff valves. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions like those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Refrigerant: 2 inches, round.
 - b. Gas: 2 inches, round.
 - 2. Valve-Tag Color:
 - a. Refrigerant: Natural.
 - b. Gas: Natural.
 - 3. Letter Color:
 - a. Refrigerant: Black.
 - b. Gas: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write the required message on and attach warning tags to equipment and other items where required.

3.6 CEILING DOT INSTALLATION

- A. Locate on ceiling grid below associated valve.

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. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. HVAC equipment quantitative-performance settings.
 - 3. Laboratory fume hood airflow balancing.
 - 4. Space pressurization testing and adjusting.
 - 5. Vibration measuring.
 - 6. Sound level measuring.
 - 7. Indoor-air quality measuring.
 - 8. Existing systems TAB.
 - 9. Verifying that automatic control devices are functioning properly.
 - 10. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.

- H. Report Forms: Test data sheets for recording test data in logical order.
- I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
- K. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- L. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- M. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- N. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- O. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance evaluated.
- P. TAB: Testing, adjusting, and balancing.
- Q. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- R. Test: A procedure to determine quantitative performance of systems or equipment.
- S. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 45 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.
- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."
- H. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Final Acceptance. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified TAB firm has evaluated and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has evaluated and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

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.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.

- C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- 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 equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance evaluated at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems-Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible, and their controls are connected and functioning.
- L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- M. Examine strainers for clean screens and proper perforations.
- N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- P. Examine system pumps to ensure absence of entrained air in the suction piping.
- Q. Examine equipment for installation and for properly operating safety interlocks and controls.
- R. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. The sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at indicated values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- S. 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 system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. 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 Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
1. Comply with requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, 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. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

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 fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 6. 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 modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicate airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - 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. 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 terminal outlets and inlets without adjusting.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Adjust using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in the 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 VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outside-air dampers to a minimum, and return- and exhaust-air dampers to a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units to maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Set terminal units to minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 8. Record the final fan performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance systems like constant-volume air systems.
 2. Set terminal units and supply fan at full-airflow condition.
 3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
 6. Set supply fan to minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Set terminal units to minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

2. Adjust the supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicate airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Evaluate the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Refrigerant Coils: Measure the following data for each coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.
 5. Refrigerant suction pressure and temperature.

3.10 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.11 PROCEDURES FOR SOUND-LEVEL MEASUREMENTS

- A. Perform sound-pressure-level measurements with an octave-band analyzer complying with ANSI S1.4 for Type 1 sound-level meters and ANSI S1.11 for octave-band filters. Comply with requirements in ANSI S1.13, unless otherwise indicated.
- B. Calibrate sound meters before each day of testing. Use a calibrator provided with the sound meter complying with ANSI S1.40 and that has NIST certification.
- C. Use a microphone that is suitable for the type of sound levels measured. For areas where air velocities exceed 100 fpm, use a windscreen on the microphone.
- D. Perform sound-level testing after air and water balancing and equipment testing are complete.
- E. Close windows and doors to the space.
- F. Perform measurements when the space is not occupied and when the occupant noise level from other spaces in the building and outside are at a minimum.
- G. Clear the space of temporary sound sources so unrelated disturbances will not be measured. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.
- H. Take sound measurements at a height approximately 48 inches above the floor and at least 36 inches from a wall, column, and other large surface capable of altering the measurements.
- I. Take sound measurements in dBA and in each of the 8 unweighted octave bands in the frequency range of 63 to 8000 Hz.
- J. Take sound measurements with the HVAC systems off to establish the background sound levels and take sound measurements with the HVAC systems operating.
 - 1. Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.
- K. Perform sound testing at <Insert number> locations on Project for each of the following space types. For each space type evaluated, select a measurement location that has the greatest sound level. If testing multiple locations for each space type, select at least one location that is near and at least one location that is remote from the predominant sound source.
 - 1. Private office.
 - 2. Open office area.
 - 3. Conference room.

4. Auditorium/large meeting room/lecture hall.
5. Classroom/training room.
6. Patient room/exam room.
7. Sound or vibration sensitive laboratory.
8. Hotel room/apartment.
9. Each space with a noise criterion of RC or NC 25 or lower.
10. Each space with an indicated noise criterion of RC or NC 35 and lower is adjacent to a mechanical equipment room or roof mounted equipment.
11. Inside each mechanical equipment room.

3.12 PROCEDURES FOR INDOOR-AIR QUALITY MEASUREMENTS

- A. After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.
- B. Observe and record the following conditions for each HVAC system:
 1. The distance between the outside-air intake and the closest exhaust fan discharge, cooling tower, flue termination, or vent termination.
 2. Specified filters are installed. Check for leakage around filters.
 3. Cooling coil drain pans have a positive slope to drain.
 4. Cooling coil condensate drain trap maintains an air seal.
 5. Evidence of water damage.
 6. Insulation in contact with the supply, return, and outside air is dry and clean.
- C. Measure and record indoor conditions served by each HVAC system. Make measurements at multiple locations served by the system if required to satisfy the following:
 1. Most remote area.
 2. One location per floor.
 3. One location for every 5000 sq. ft.
- D. Measure and record the following indoor conditions for each location two times at two-hour intervals, and in accordance with ASHRAE 113:
 1. Temperature.
 2. Relative humidity.
 3. Air velocity.
 4. Concentration of carbon dioxide (ppm).
 5. Concentration of carbon monoxide (ppm).
 6. Nitrogen oxides (ppm).
 7. Formaldehyde (ppm).

3.13 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or ungrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.14 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances (code required minimums must meet or exceed rates indicated on plans):
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Minus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: minus 10 to plus 10 percent.
 - 3. Heating-Water Flow Rate: minus 10 to plus 10 percent.
 - 4. Cooling-Water Flow Rate: minus 10 to plus 10 percent.

3.15 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: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being evaluated and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. 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 but does not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of TAB firm.
 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 firm 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. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Evaluate conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings include settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
 - 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.

2. Motor Data:
 - a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

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. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.
 - g. Cooling coil static-pressure differential in inches wg.
 - h. Heating coil static-pressure differential in inches wg.
 - i. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model numbers.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drops in inches wg.
- d. Outside-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

H. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

- a. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
- g. Number of belts, make, and size.

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.

I. 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 airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
- K. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Unit make and model number.
 - d. Compressor make.
 - e. Compressor model and serial numbers.
 - f. Refrigerant weight in lb.
 - g. Low ambient temperature cutoff in deg F.
- L. Vibration Measurement Reports:
1. Date and time of test.
 2. Vibration meter manufacturer, model number, and serial number.
 3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
 4. Diagram of equipment showing the vibration measurement locations.
 5. Measurement readings for each measurement location.
 6. Calculate isolator efficiency using measurements taken.
 7. Description of predominant vibration source.
- M. Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:
1. Date and time of test. Record each tested location on its own NC curve.

2. Sound meter manufacturer, model number, and serial number.
3. Space location within the building including floor level and room number.
4. Diagram or color photograph of the space showing the measurement location.
5. Time weighting of measurements, either fast or slow.
6. Description of the measured sound: steady, transient, or tonal.
7. Description of predominant sound source.

N. Indoor-Air Quality Measurement Reports for Each HVAC System:

1. HVAC system designation.
2. Date and time of test.
3. Outdoor temperature, relative humidity, wind speed, and wind direction at start of test.
4. Room number or similar description for each location.
5. Measurements at each location.
6. Observed deficiencies.

O. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.17 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. Randomly 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 the room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Measure sound levels at two locations.
 - e. Measure space pressure of at least 10 percent of locations.
 - f. Verify that balancing devices are marked with final balance position.
 - g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence 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 Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The 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 the 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.
 6. TAB firm shall recheck all measurements and adjust. Revise the final report and balancing device settings to include all changes and resubmit the final report.
 7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.18 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC 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:

- 1. Insulation Materials:

- a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - e. Phenolic.
 - f. Polyisocyanurate.
 - g. Polyolefin.
 - h. Polystyrene.
 - i. Mass loaded vinyl

- 2. Adhesives.
 - 3. Mastics.
 - 4. Lagging adhesives.
 - 5. Sealants.
 - 6. Factory-applied jackets.
 - 7. Field-applied fabric-reinforcing mesh.
 - 8. Field-applied cloths.
 - 9. Field-applied jackets.
 - 10. Tapes.
 - 11. Securements.
 - 12. Corner angles.

- B. Related Sections:

- 1. Division 21 Section "Fire-Suppression Systems Insulation."
 - 2. Division 22 Section "Plumbing Insulation."
 - 3. Division 23 Section "Metal Ducts" for duct liners.
 - 4. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.

1.3 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aeroflex
2. Armacell
3. Certain Teed Corp.
4. Johns Manville
5. Knauf Insulation
6. Owens Corning
7. Pittsburg Corning Corp.

- B. Listing manufacturers' name does not guarantee approval. All equipment must meet or exceed the quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail attachment and covering of heat tracing inside insulation.
 3. Detailed insulation application at pipe expansion joints for each type of insulation.
 4. Detailed insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 6. Detailed application of field-applied jackets.
 7. Detail application at linkages of control devices.
 8. Detailed field application for each equipment type.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - b. Sheet Form Insulation Materials: 12 inches square.
 - c. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - d. Sheet Jacket Materials: 12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Qualification Data: For qualified Installer.
- E. 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.
- F. Field quality-control reports.

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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting 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 the manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and 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 Part 3 schedule articles for where insulating materials shall be applied.

- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that encounter stainless steel shall have a leachable chloride content of less than 50 ppm when evaluated 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. Calcium Silicate:
 - 1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in performing insulation to cover valves, elbows, tees, and flanges.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Board Insulation: ASTM C 552, Type IV.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 6. Factories fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- I. 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.
- J. 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 FSK jacket. For equipment applications, provide insulation with factory applied FSK jacket. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.
 - 2. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.

- L. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factories apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory applied ASJ complying with ASTM C 1393, Type II, or Type IIIA Category 2, or with properties like ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.
- N. Phenolic:
1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 3. Factories fabricate shapes according to ASTM C 450 and ASTM C 585.
 4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: ASJ.
 - b. Board for Duct and Plenum Applications: ASJ.
 - c. Board for Equipment Applications: ASJ.
- O. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
1. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
 2. The flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as evaluated by ASTM E 84.
 3. Fabricate shapes according to ASTM C 450 and ASTM C 585.
 4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Pipe Applications: ASJ-SSL.
 - b. Equipment Applications: ASJ-SSL.
- P. 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.
- Q. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV, or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
- R. Mass Loaded Vinyl: Flexible, non-reinforced mass loaded vinyl that resists the passage of sound waves and reduces the transmission of airborne noise. Weight of 1 lb./sq ft; 0.100" thickness, -40 deg F to 180 deg F temperature range. Noise transmission loss (db) shall be included in the submittal per ASTM E-90-97 E413-87.

2.2 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
- G. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- H. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-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 and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 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 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.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry 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, 3 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 200 deg F.
 3. Solids Content: 63 percent by volume and 73 percent by weight.
 4. Color: White.

2.4 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 duct, equipment, and pipe insulation.
 3. Service Temperature Range: Minus 50 to plus 180 deg F.
 4. Color: White.

2.5 SEALANTS

- A. Joint Sealants: Cellular-Glass, Phenolic, Polyisocyanurate and Polystyrene Products.
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.
 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 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.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when evaluated according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when evaluated according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when evaluated according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when evaluated according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when evaluated according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

2.8 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.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. 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. Color: Color-code jackets based on system.
 - 3. 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.
 - 4. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Finish and thickness are indicated in field-applied jacket schedules.
 - b. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. 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 cover.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricates fitting covers only if factory-fabricated fitting covers are not available.
 - 2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - b. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

- c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- d. 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 cover.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricates fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with white aluminum-foil facing.
- F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when evaluated according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when evaluated according to ASTM E 84.
- G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when evaluated according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when evaluated according to ASTM E 84.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.10 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/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. 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/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 4 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
 2. Film Thickness: 6 mils.
 3. Adhesive Thickness: 1.5 mils.
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.

2.11 SECUREMENTS

- A. Bands:
1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
 2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- 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-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that can hold insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum, 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: Baseplate fastened to projecting spindle that can hold 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 inch thick by 1-1/2 inches in 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 can hold insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum, 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, aluminum 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: 0.062-inch soft-annealed, stainless steel.

2.12 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been evaluated 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 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 mils thick and an epoxy finish 5 mils thick 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 F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cement with clean potable water; if insulating cement is 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 equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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 the 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 end 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 inches o.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 o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and 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 inches beyond damaged areas. Adhere, staple, and seal patches like 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. 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 joints 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 joints 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. 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 Division 07 Section "Penetration Firestopping" firestopping and fire-resistant joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not over compress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Improve insulation over anchor pins and attach speed washers.
 - g. 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.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches.
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:

1. Provide 1" foam-core insulation on all chilled water pumps. Install pump insulation per foam-core insulation manufacturer's pump insulation installation instructions. Include pump insulation installation instructions with insulation submittals.
2. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article 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 and finish 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. But each section is close to the next and held 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 the 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, vessels, and equipment. 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 the 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 inches over 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 the first coat is dry, apply and trowel the 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.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 - 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
 - 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- 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 block insulation of same material and thickness as pipe insulation.
 - 4. Finish flange insulation same as pipe insulation.
- 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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

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 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but 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.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- 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 the 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.

3.10 MINERAL-FIBER INSULATION INSTALLATION

- 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 but 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.
- E. 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 75 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 the surface at cross bracing.
 - c. Pins may be omitted from the top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Improve 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-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 F at 18-foot intervals. 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 2 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.
- F. 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 75 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 the surface at cross bracing.
 - c. Pins may be omitted from the 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-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 F at 18-foot intervals. 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 2 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.

3.11 PHENOLIC INSULATION INSTALLATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. 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 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. 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 block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
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.

3.12 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate 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.

3.13 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 the 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 polyolefin 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 polyolefin 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 cut sections of polyolefin pipe and sheet 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.
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.

3.14 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene 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.

3.15 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-inch overlap 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 the same material as jacket.
3. Secure jacket to insulate with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps 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-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. 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-inch overlap 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 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When choosing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.16 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

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: Coat exposed outdoor flexible elastomeric insulation with two coats of manufacturer's recommended protective white coating; or cover with aluminum jacketing all exposed outdoor flexible elastomeric insulation, in lieu of paint.
- 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.

3.17 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.
 2. Inspect field-insulated equipment, 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 type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 3. 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.

3.18 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, concealed supply, return, and outdoor air.
 2. Indoor, exposed outdoor air.
 3. Outdoor, concealed supply and return.
 4. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 1. Fibrous-glass ducts.

2. Metal ducts with duct liners of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Indoor, exposed supply and return air in air conditioned, occupied spaces.
4. Exhaust ductwork.
5. Factory-insulated flexible ducts.
6. Factory-insulated plenums and casings.
7. Flexible connectors.
8. Vibration-control devices.
9. Factory-insulated access panels and doors.

3.19 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply-air Ducts, concealed (installed above ceilings):

1. Mineral-Fiber Blanket: 2 inches thick and installed R-6.0.

B. Return Air Ducts, Transfer Ducts; Concealed (installed above ceilings):

1. Mineral-Fiber Blanket: 2 inches thick and installed R-6.0.

C. Exposed Supply and Return Ductwork in Air Conditioned, Occupied Spaces, and Exhaust Air Ductwork:

1. Wrap the first 10'-0" of exposed supply, return or exhaust ductwork in occupied areas with a mass loaded vinyl noise barrier.

D. Exposed Supply and Return Ductwork exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms or Mechanical Rooms used as Return Air Plenums) and Exposed in Non-Air-Conditioned Spaces (Boiler Rooms, et. Al):

1. Mineral-Fiber Board Insulation: 2 inches thick and installed R-6.0.

E. Outside-Air Ducts:

1. Mineral-Fiber Blanket: 2 inches thick and installed R-6.0.

3.20 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Supply-air, return-air and outside-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.21 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is the Contractor's option.

- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles as recommended by the manufacturer.

3.22 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 is in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.23 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate, Equipment Drain Water:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 3/4 inch thick.
 - c. Polyisocyanurate: 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping:
 - 1. Insulation shall be installed per the manufacturer's recommendations.
- C. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
 - b. Cellular Glass: 1-1/2 inches thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- D. Hot Service Vents:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
 - b. Cellular Glass: 1-1/2 inches thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

3.24 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be as recommended by the manufacturer.

3.25 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. Ducts, Plenums, and Piping, concealed (installed above ceilings) and exposed in Air-Conditioned Occupied Spaces:
 1. None.
- D. Ducts, Plenums, and Piping, Exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms and Mechanical Rooms used as Return Air Plenums):
 1. 8-ounce canvas with lagging adhesive.
- E. Ducts, Plenums, and Piping, Exposed in Non-Air-Conditioned Spaces (Boiler Rooms, et. al.):
 1. PVC: 20 mils thick (N/A if installed in a return air plenum).
 2. Aluminum, Smooth: 0.016 inch thick.
- F. Equipment, concealed (installed above ceilings):
 1. None.
- G. Equipment, Exposed (all applications):
 1. PVC: 20 mils thick (N/A if installed in a return air plenum)
 2. Aluminum, Smooth: 0.016 inch thick.

3.26 OUTDOOR, 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. Ducts and Plenums, Concealed:
 1. PVC: 20 mils thick.
 2. Aluminum, Smooth: 0.016 inch thick.
- D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 1. Aluminum, Smooth: 0.016 inch thick.
- E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
 1. Aluminum, Smooth with 0.032 inch thick.

- F. Equipment, Concealed:
 - 1. None.
- G. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Painted Aluminum, Smooth: 0.016 inch thick.
- H. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
 - 1. Aluminum, Smooth with 0.032 inch thick.
- I. Piping, Concealed:
 - 1. None.
- J. Piping, Exposed:
 - 1. PVC, Color-Coded by System: 20 mils thick.
 - 2. Aluminum, Smooth: 0.016 inch thick.

3.27 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 23 07 00

SECTION 23 09 00 - BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Direct Digital Controls (DDC) – BACnet compliant
- B. Programming and Graphics
- C. Controllers (Global, Standalone, Application Specific)
- D. Communications
- E. Sensors
- F. Valves, Dampers, and actuators
- G. Electrical appurtenances and wiring systems.
- H. Sequence of Operation

1.2 RELATED WORK:

- A. Section 23 -Mechanical General Requirements
- B. Division 26 -Electrical

1.3 SHOP DRAWINGS:

- A. System Architecture (BACnet LAN scheme)
- B. Wiring diagrams
- C. Valves and actuators
- D. Dampers and actuators
- E. System schematics for all mechanical systems
- F. Material lists with part numbers and quantities, as appropriate.
- G. Technical/Product data sheets for each piece of equipment
- H. Sequence of Operation for each system
- I. As-built drawings of installed system

1.4 SUBMITTALS:

- A. Submit Shop Drawings of the complete Building Automation System (DDC System) for review and approval.
- B. Drawings shall be submitted in standard sheet size format (8-1/2" x 11", 11" x 17", or 24" x 36").
- C. Drawings shall be bound within a standard 3-ring binder, cover, or other suitable permanent binder. For projects in which the controls submittals will be less than one-half inch thick, the submittal documents may be securely stapled in the upper left-hand corner provided the cover sheet and back sheet are printed on card stock (heavy bond paper).
- D. Submit five (5) copies of submittal drawings for review by the Owner.
- E. At completion, furnish as-built drawings in bound form and on CD.
- F. Submit documentation for all DDC programming in graphical form (AutoCAD or Visio format, or equal) as a part of the as-built documentation.
- G. Submit manufacturer's operating instruction manual for the DDC control system for use in owner training.
- H. Submit Certificate of Training upon completion of all scheduled training of the owner's operating personnel.

- 1.5 CODES AND REFERENCE STANDARDS: The latest edition of the following standards and codes in effect and amended as of the date of the supplier's proposal, and any subsections thereof as applicable, shall govern the design and selection of equipment and material supplied.
- A. NFPA 70 - National Electrical Code (NEC)
 - B. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers (Handbooks)
 - C. ANSI/ASHRAE Standard 135 (1995) – BACnet: A Data Communication Protocol for Building Automation and Control Networks
 - D. UL 916 - Standard for Energy Management Equipment
 - E. FCC – Part 15, Subpart J
 - F. City, County, State and Federal regulations and codes in effect as of the date of the Contract
- 1.6 PERMITS: Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for all necessary approvals by the governing authorities.
- 1.7 QUALITY ASSURANCE:
- A. Responsibility: The supplier of the HVAC digital logic control system shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.
 - B. Component Testing: Maximum reliability shall be achieved through extensive use of high quality, pre-tested components. The manufacturer prior to shipment shall individually evaluate each controller, sensor, and all other DDC components.
 - C. Tools, Testing and Calibration Equipment: The control system supplier shall provide all tools, testing, and calibration equipment necessary to ensure reliability and accuracy of the control system.
 - D. Authorized Representative: The systems control contractor shall have been in business a minimum of three years and be the authorized representative for the manufacturer of the BACnet components.
- 1.8 WARRANTY: The DDC control system installed under this Specification shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months after final acceptance by the Owner. If within the twelve (12) month warranty period, any equipment, software, or labor is found to be defective in workmanship or materials, it shall be replaced free of charge by the Controls system installer. A warranty service shall be available on the job site during normal working hours.
- 1.9 PREVENTATIVE MAINTENANCE: The DDC control system installed as part of this project shall include a preventative maintenance schedule including two four-hour inspections per building twice within the first year of operation. The college desires one service company to have responsibility for maintaining the entire campus-wide automation system. Therefore, the successful bidder shall be responsible for conducting similar inspections at all campus buildings with DDC controls.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Installation of the system shall be by qualified employees of the temperature control system manufacturer or its exclusive authorized representative and qualified subcontractor. Indirect temperature control work by non-qualified installing contractors performing work without direct supervision from the authorized representative will not be accepted.

- B. The installation contractor shall provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the control system.

2.2 SYSTEM REQUIREMENTS:

A. Owner Requirement:

ALL POINTS SHALL HAVE FULL RANGE MANUAL OVERRIDES, SYSTEM SAFETIES SHALL HAVE PRIORITY OVER MANUAL OVERRIDE.

- B. Furnish a totally native BACnet-based system for distributed logic control in accordance with this specification. The system operator's terminal, all global controllers, and all input/output devices shall communicate using the protocols and local area network (LAN) standards as defined by ANSI/ASHRAE Standard 135 – 1995 (BACnet). No gateways shall be used.
- C. The proposed system must be completely compatible with the owner's existing web based Tridium DDC control system. The controls contractor shall include in his proposal all the hardware, software, engineering, or graphics development required to integrate the new control system into the existing graphical user interface. If a separate front-end computer is required then the contractor is also required to provide the necessary hardware, programming, and software to communicate to all the owner's existing buildings and provide graphic displays for the new building and all equipment currently controlled by the Tridium system.
- D. The system shall be a complete system of automatic temperature controls of the Direct Digital Control (DDC) type with electric and electronic accessories and components as indicated and as required.
- E. All control items, except thermostats, sensors and transmitters located in rooms shall be properly identified with engraved plastic nameplates permanently attached. Nameplates shall have white letters on a black background.
- F. Room thermostat, sensor and transmitter locations shall be coordinated to align vertically or horizontally with adjacent light switches or other control devices. Room thermostats and sensors shall be mounted with the bottom 5'-0" above the floor.
- G. Owner's Representative shall furnish disk file copies of the building floor plan(s) in AutoCAD (or other compatible drafting package format) for use by the DDC system Contractor in creating custom system graphics for displays.

2.3 SENSORS, TRANSMITTERS AND THERMOSTATS:

- A. Temperature Sensors: Thermistor type with an accuracy of plus or minus 0.40-degree F over the entire control range. Sensors for pipe installations shall be immersion type, brass well, and thermistor with integral lead wire. Sensors for duct application shall be insertion probe type, stainless steel probe, integral handibox, and thermistor with integral lead wire. Space temperature sensors shall be compatible with the unit controller and shall be provided in a decorative metal or plastic enclosure. Space temperature sensors shall be provided with setpoint adjustment (lever or slide type), and override pushbutton, and connection port for field service tool. Outdoor temperature sensors shall be mounted inside a protective weather and sun shield.
- B. Space Temperature Sensor: Wall mounted room sensor, no occupant controls. The controller shall also be capable of functioning as a field service tool to allow maintenance personnel to observe and adjust all control parameters resident in the terminal unit controller. These control parameters shall also be adjustable from the global controller. The sensor shall be standard two-wire connection and have a thermistor, housed in a decorative plastic enclosure.
- C. Humidity Sensors: Thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). The operating range shall be 0 to 100% RH and 32-to-140-degree F. Duct mounted type sensors shall have a stainless-steel insertion element, sealed to prohibit corrosion. Sensors shall be selected for wall, duct, or outdoor type installation as appropriate.

- D. Current Switches (Type 1): For proving fan or pump operational status, provide split-core type status switches with adjustable setpoint and solid-state internal circuitry. Current switch shall have induced power, trip point set adjustment to plus or minus 1% over a range of 1 to 135 amps, trip and power LED, and field adjustable to indicate both On-Off conditions and loss of load (broken belt, etc.). Units shall have a five-year manufacturer's warranty. The current switches shall be Hawkeye Series H-908 by Veris Industries or approved equal.
- E. Low Temperature Sensors: For sensing low temperatures in air handling units, provide SPST type switch, 35-to-45-degree F range, manual reset, vapor charged twenty-foot-long sensing element, and 120-volt electrical power connection.

2.4 MISCELLANEOUS MATERIALS:

- A. Panels: All enclosures for DDC controllers and devices shall be fabricated in accordance with UL Standards from code gauge steel. Enclosures shall be provided with a continuous hinge on the door and a flush latching mechanism. Enclosures shall be shop painted with standard grade enamel coating. Back panels shall be furnished when required to facilitate installation of boards or accessories. All enclosures installed outdoors shall be constructed to NEMA 3R standards. All controllers shall be installed within an approved enclosure unless the controller is installed within the control cabinet section of the equipment that it is intended to control. Enclosures shall facilitate the mounting of gauges, switches, pilot lights, and the like, on the face panel when required. Control devices that are mounted on the face of the panel shall be identified with engraved nameplates.
- B. Power Transformers: Step-down power transformers shall be provided for all DDC controllers and associated accessory devices as required. Transformers shall be sized and selected to accommodate all connected accessory items. Transformers shall be UL Listed Class 2 type with 120 VACS primary, 24 VACS secondary.
- C. Relays: Miscellaneous control relays shall be provided as required to energize or control equipment and devices within the control system. Relays shall be located as close as practical to the controlled device (motor, motor starter, etc.). Where approved by NEC, relays may be installed within starters and equipment control panels where space is available. Relays installed outside of the controlled device shall be provided with a NEMA enclosure suitable for the location where installed.
- D. Wiring: All wiring shall be installed in a neat and professional manner. Control wiring shall not be installed in power circuit conduits or raceways unless specifically approved for that purpose. All wiring shall be plenum rated cable concealed and in EMT conduits when exposed.
 - 1. Provide all interlock and control wiring. Provide wiring as required by functions as specified and as recommended by equipment and device manufacturers to achieve the specified control functions.
 - 2. Low voltage conductors shall be stranded bare or tinned copper with premium grade polymer alloy insulation. For shielded cable, furnish multi-conductor of overall polyester supported aluminum foil with stranded tinned copper drain wire to facilitate grounding. The coaxial shield shall be copper braided type. Provide shielded cable where recommended by the equipment or device manufacturer, grounded in strict accordance with the manufacture's recommendations.
 - 3. Low voltage wiring shall be UL Listed type for the intended application. Non-plenum type cable shall be UL Type CM and /or CMR. Plenum type cable shall be UL type CMP and /or CL3P for approved plenum installations.

Direct Digital Control System

- 2.7 GENERAL: The Direct Digital Control (DDC) System shall consist of native BACnet type global controller(s) and standalone or application specific unitary controller(s) configured as a distributed communications network composed of one or more levels of BACnet compliant local area networks (LAN). No gateways shall be used except when required to interface with specific equipment furnished by another manufacturer (e.g.: chiller controllers, packaged equipment

controllers, etc.) . The intent of the distributed control strategy is to install the controllers near the equipment being controlled, and to distribute the processing to each standalone DDC panel. In the event of a communications failure of the BACnet LAN, the controllers shall be capable of operating in standalone mode. All devices (global controllers, standalone controllers, programmable controllers, etc.) shall be UL Listed, FCC approved, and BACnet compliant.

2.8 WORK INCLUDED:

- A. Furnish a totally native BACnet-based system based on distributed logic control in accordance with this specification section. The existing operator's terminal, all global controllers, logic controllers, and all input/output devices shall communicate using the protocols and local area network (LAN) standards as defined by ANSI/ASHRAE Standard 135-1995, BACnet. All DDC controllers, including unitary controllers, shall be native BACnet devices. In general, no gateways shall be used except when required to interface with specific equipment furnished by another manufacturer. Scope of work will include, but not be limited to, the following:
1. Provide all necessary BACnet compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for every controller in the system, including unitary controllers. All direct digital logic hardware is to comply with BACnet.
 2. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.
 3. Implement the detailed design for all system-standard analog and binary objects, distributed control and system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
 4. Design, provide, and install all equipment enclosures, panels, data communication network cables needed, and all associated hardware.
 5. Provide and install all interconnecting cables between supplied enclosures, logic controllers, and input/output devices.
 6. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this contract.
 7. Provide complete manufacturer's product data for all items that are supplied. Include vendor name of every item supplied.
 8. Provide qualified supervisory personnel and technicians at the job site to assist in all phases of system installation, startup, and commissioning.
 9. Provide operator training as described in this Section.
 10. Provide "as-built" documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum of which accurately represents the final system.
 11. Provide new dampers, valves, actuators, sensors, controllers, and the like. No used components shall be provided as any part or piece of the installed system.

2.9 SYSTEM DESCRIPTION:

A. General Requirements

1. The existing campus automation system is Tridium. The existing graphical user interface provides web access for monitoring, controlling, scheduling, and alarm notification for all buildings connected to the system. The CAS utilizes the campus WAN to interconnect all the buildings to the network server. At the conclusion of this project, the new building system will be added to the existing server software and will provide the same functionality and look like the existing system.
2. A distributed logic control system complete with Direct Digital Control (DDC) and Direct Analog Control (DAC) software shall be provided. System shall be totally based on ANSI/ASHRAE Standard 135 - 1995, BACnet. This system is to control all mechanical

equipment, including all unitary equipment such as packaged air conditioning units, and all air handling units, boilers, chillers, and any other listed equipment on this project using native BACnet-compliant components.

3. The entire processing system shall be in complete compliance with the BACnet standard. The system shall use BACnet protocols and LAN types throughout and exclusively. Non-BACnet compliant or proprietary equipment or systems (including gateways, except as specified previously) shall not be acceptable and are specifically prohibited.
4. All logic controllers for terminal units, air handlers, central mechanical equipment, and Microsoft Windows-based operator's terminal(s) shall communicate and share data, utilizing only BACnet communication protocols.
5. All logic controllers shall be fully programmable. Programmable controllers for every terminal unit, air handler, all central plant equipment, and any other piece of controlled equipment shall be provided. Programming tools shall be provided as part of the operator workstation for every controller supplied for the project.
6. The Controls Contractor shall assume complete responsibility for the entire controls system as a single source. He shall certify that he has factory-trained personnel on staff under his direct employment daily. These employees shall be qualified to engineer, program, debug, and service all portions of the BACnet based logic control system. This shall include the operator's terminal, global controllers, routers, programmable controllers, terminal unit controllers, sensors, and all other components of the system.

B. Basic System Features

1. Zone-by-zone direct digital logic control of space temperature, scheduling, optimum start, equipment alarm reporting, and override timers for after-hours usage. A zone is the area served by one HVAC logic controller unit, VAV box, or multi-zone unit.
2. The operator's terminal software shall be Microsoft Windows 7 based. The Building Automation System application program shall be written to communicate specifically utilizing BACnet protocols. Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Software should support Windows Dynamic Data Exchange (DDE) interfaces. Software shall strictly follow Microsoft Windows API guidelines. Systems using proprietary software or operating systems other than those described above are prohibited. The operation of the terminal software shall be simple and intuitive.
3. The operator's terminal software shall contain an easy-to-operate system allowing configuration of system-wide BACnet controllers, including management and display of the controller programming. This system shall provide the capability to configure controller binary and analog inputs and outputs.
4. Operator's terminal operating 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. Graphics generation shall be done using standard Windows packages. No proprietary graphics generation software shall be required.
5. When specified, at least one operator's terminal shall be equipped to function as a system server. This system server shall store custom copies of loadable software for all field components and shall be capable of automatic or manual reloading of such software into the field components as required. The system server shall also gather and archive system operating data, such as trend logs, energy logs, and other historical operating data.
6. Complete energy management firmware, including self-adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the operator's terminal for operation. Operator's terminal software is to be used for access to field-based energy management control firmware only.

7. Priority password security systems shall prevent unauthorized use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.
8. Equipment monitoring and alarm functions, including information for diagnosing equipment problems shall be included with the system.
9. The complete system, including, but not limited to terminal unit controllers, global controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in global controller memory shall be battery-backed up for a minimum of one (1) year. Logic controllers for all air handlers and all unitary equipment shall utilize EEPROM for all variable data storage. Batteries on unitary controllers shall not be allowed.
10. System design shall be modular and have proven reliability.
11. All software and /or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.
12. The system shall be capable of equipment runtime totalization of fans, heaters, boilers, pumps and the like and capable of alarm generation and alarm dial-out to remote sites.
13. Communication wiring from field controllers shall NOT be run in star patterns.
14. All controllers shall communicate using protocols and LAN types contained in the ANSI/ASHRAE Standard 135 – 1995, BACnet.
15. All DDC hardware and software shall be designed and manufactured by U.S. corporations. All hardware shall be Listed Underwriters Laboratories (UL) for Open Energy management Equipment (PAZX) under the UL Standard for Safety (UL 916) in both the U.S. and Canada, with integral labels showing the rating.
16. All hardware shall be in compliance with FCC Part 15, Subpart J, Class A.

2.10 OPERATOR'S TERMINAL:

A. Operating System

1. The GUI shall run on Microsoft Windows 7 Professional.
 - a. The GUI shall employ browser-like functionality for ease of navigation. It should include a tree view (like Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. 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. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (like a URL line), that displays the location and the selected object identification.
 - b. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
 - i. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG 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.
 - ii. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
 - iii. Graphics shall support layering and each graphic object shall be configurable for assignment to one layer. A minimum of six layers shall be supported.

- iv. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - v. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - vi. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - vii. 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.
 - viii. Adjustments to analog objects, such as set points, shall be done by right clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
- c. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
- i. Create, delete, or modify control strategies.
 - ii. Add/delete objects to the system.
 - iii. Tune control loops through the adjustment of control loop parameters.
 - iv. Enable or disable control strategies.
 - v. Generate hard copy records or control strategies on a printer.
 - vi. Select points to be alarmable and define the alarm state.
 - vii. Select points to be trended over a period and initiate the recording of values automatically.
- d. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional helpful information shall be available using hypertext. All system documentation and help files shall be in HTML format.
- e. Security. Each operator shall be required to log on to that system with a username and password to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged in from the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- f. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- g. Alarm Console
- i. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - ii. 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. This window will notify the operator of new

alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2. WEB BROWSER CLIENTS

- a. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
- b. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc. to allow the Web browser to function with the DDC system, shall not be acceptable.
- c. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- d. The Web browser client shall support at a minimum, the following functions:
 - i. User log-on identification and password shall be required. If an unauthorized user attempts to access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - ii. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - iii. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - iv. Storage of the graphic screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - v. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - vi. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - vii. Modify common application objects, such as schedules, calendars, and set points 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.
 - viii. 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.
 - ix. View logs and charts
 - x. View and acknowledge alarms.
 - xi. Setup and execute SQL queries on log and archive information.

- xii. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- xiii. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

C. Display of Scheduling Object Information

1. The operator's terminal display of weekly schedules shall show all information in convenient 7-day (weekly) format for each schedule. This includes all on/Off times (accurate to the minute) for each day's events.
2. BACnet exception schedules (non-normal schedules, such as holidays or extraordinary events) shall display all dates that are an exception to the normal weekly schedules. These specialty schedules shall be displayed at the operator's terminal in a format like the weekly schedules, with input requirements like weekly schedules. Holiday and event schedules shall be entered as either single day entries, date-to-date entries (covering a range of days), or by weekday (for example, a specific day of a given week each month). The operator shall be able to scroll through the months for each year as a minimum.
3. At the Operator's Terminal, the system user shall be capable of changing all information for a given weekly or specialty schedule if logged on with the appropriate security access.

D. Alarm Indication

1. Operator's Terminal shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) being run at the time (such as a word processor). Printout of alarms shall be sent to the assigned terminal and port.
2. Alarm messages shall be logged. Alarm log shall be archived to the hard disk of the system terminal. Each entry shall include a description of the event which generated the alarm, time and date of alarm occurrence, time, and date of status return to normal, and time and date of alarm acknowledgment.
3. Alarm messages shall be provided in user definable text (English or other user defined language) and shall be accessible either at the Operator's Terminal or via remote (modem) communication. When specified, designated alarms shall be available for dial out to pager alarms for 'on call' personnel.

E. Trendlog Information

1. DDC system shall be capable of periodically monitoring the values or status of selected feedback or control data from the system global controller(s) or field controllers and archiving this information on the operator's terminal. Archived files shall be appended with new sample data, allowing samples to be accumulated over a user defined period. Systems that overwrite previously archived data samples shall not be allowed, unless limited file size is specified. Samples in a trend log shall be available for viewing at the operator's terminal. Displays of trendlog data shall be in spreadsheet format. Operator shall be capable of scrolling through all trendlog data. The system shall automatically open archive files as needed to display archived data when the operator scrolls through the data vertically. All trendlog information displays shall be shown in standard engineering units.
2. Software shall be included that can graph 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 colors. Graphs shall show object type values relative to time.

3. Operator shall be able to change trendlog setup information. This shall include the data points and status information being trendlogged as well as the interval at which the information is to be logged. All trendlog functions shall be password protected. The operator shall be capable of viewing or setting up a trendlog for any prompted or read-only item.
4. The system shall provide a means for the operator to directly export data to a comma-delimited file format for use in third-party software spreadsheets or other database programs. The system operation shall not be affected in any way by this data exchange.

F. Energy Log Information

1. DDC system shall periodically gather energy log data stored in field terminal controllers and archive this information on the operator terminal's hard disk. Archive data shall be appended with the new data and allow data to be accumulated over several years. Systems that overwrite archived data shall not be allowed unless limited file size is specified. The system shall automatically open archive files as needed to display archived data when the operator scrolls through the data. All energy log information shall be displayed in standard engineering units.
2. System software shall be capable of graphing the Energy Log data. Software shall be capable of creating graphs in two-axis (x, y) format that shows recorded data relative to time. All data shall be stored in comma-delimited file format for direct use by third party software spreadsheets or other database programs. System operation shall not be affected by on-line access to the energy information.
3. The operator shall be able to modify the energy log setup information. This shall include which meters are to be logged, meter pulse value, and what types of energy units are being logged. All energy meters monitored by the system shall be capable of being logged. All energy logging operations shall be password protected.
4. Provide capability for the operator to export to a comma-delimited file format all energy-logged data for use by third party software spreadsheets or other database programs. System operation shall not be affected by on-line access to the energy information.

G. Configuration/Setup

1. Provide means for the operator to display and change the system configuration. This shall include, but not be limited to system time, day of the week, date of daylight savings time set forward/back, printer termination, port addresses, modem port and speed, and the like. Items shall be modified utilizing easily understood terminology by means of simple mouse/cursor key movements.

H. Programming Tools

1. Operator's Terminal shall include programming tools for all controllers supplied. If a new software package is proposed it is the contractor's responsibility to load all programming tools/ engineering software on all the owner's existing operator terminals and laptops, as well as provide all connectors for connection to field devices with portable terminals. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from different types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
2. Users shall be able to pick graphical function block from the menu and place it on screen. Programming tools shall place lines connecting appropriate function blocks together automatically. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to the controller without any reentry of data.

3. Programming tools shall include a test mode. Test mode shall show user the real-time data on top of graphical display of selected function blocks. Data shall be updated in real-time with no interaction by the user. Function blocks shall be animated to show status of data inputs and outputs. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

2.11 GLOBAL BUILDING CONTROLLERS (GBCs)

- A. The controls contractor shall supply one or more global controllers as part of this contract. The number of global controllers required is dependent on the type and quantity of DDC devices.
- B. The Global Building Controller shall provide the interface between the LAN and the field control devices and provide global supervisory control functions over the control devices connected to the GBC. It shall be capable of executing application control programs to provide:
 - a. Calendar functions
 - b. Scheduling
 - c. Trending
 - d. Alarm monitoring and routing.
 - e. Time synchronization
 - f. Integration of LonWorks controller data and BACnet controller data
 - g. The GBC must provide the following hardware features as a minimum:
 1. One Ethernet Port - 10 Mbps
 2. One RS-232 port
 3. One BACnet MS/TP Port
 4. Battery Backup
 5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 6. The GBC must be capable of operation over a temperature range of 0 to 55°C.
 7. The GBC must be capable of withstanding storage temperatures of between 0 and 70°C.
 8. The GBC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.
 9. The GBC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the GBC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
 10. Event Alarm Notification and actions
 11. The GBC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 12. The GBC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.

13. Alarm generation shall be selectable for annunciation type and acknowledgement requirements.
- h. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 - i. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - j. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
 - k. Control equipment and network failures shall be treated as alarms and annunciated.
 - l. Alarms shall be annunciated in any of the following manners as defined by the user:
 - m. Screen message text.
 - n. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - i. Day of week
 - ii. Time of day
 - iii. Recipient
 - o. Pagers via paging services that initiate a page on receipt of email message.
 - p. Graphic with flashing alarm object(s)
 - q. Printed message, routed directly to a resolute alarm printer.
 - r. Audio messages
 - s. The following shall be recorded by the NAC for each alarm (at a minimum):
 - i. Time and date
 - ii. Location (building, floor, zone, office number, etc.)
 - iii. Equipment (air handler #, accessway, etc.)
 - iv. Acknowledge time, date, and user who issued acknowledgement.
 - v. Number of occurrences since last acknowledgement.
 - t. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 - u. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 - v. A log of all alarms shall be maintained by the GBC and/or a server (if configured in the system) and shall be available for review by the user.
 - w. Provide a “query” feature to allow review of specific alarms by user defined parameters.
 - x. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 - y. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- C. Data Collection and Storage
- a. The GBC shall have the ability to collect data for any property of any object and store this data for future use.

- b. The data collection shall be performed by log objects, resident in the GBC that shall have, at a minimum, the following configurable properties:
 - c. Designating the log as interval or deviation.
 - d. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - e. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - f. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - g. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 - h. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is configured) or a standard Web Browser.
 - i. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
 - j. All log data shall be available to the user in the following data formats:
 - k. HTML
 - l. XML
 - m. Plain Text
 - n. Comma or tab separated values.
 - o. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
 - p. The GBC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other GBC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - q. Archive on time of day.
 - r. Archive on user-defined number of data stores in the log (buffer size)
 - s. Archive when log has reached its user-defined capacity of data stores.
 - t. Provide ability to clear logs once archived.
- D. AUDIT LOG
- a. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
 - b. Time and date
 - c. User ID
 - d. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- E. DATABASE BACKUP AND STORAGE
- a. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

- b. Copies of the current database and the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
- c. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, if XML format is supported.

2.12 ROUTER, CONVERTER, OR REPEATER

Routing functions shall be performed using only BACnet standard protocols as defined by ASHRAE Standard 135-1995. The converter interconnects a standard computer serial port with an MS/TP LAN. Repeater functions shall be managed by a device to selectively interconnect four (4) portions of MS/TP LAN as a minimum.

1. ROUTERS: The router function shall perform the BACnet definition functions of interconnecting two or more BACnet LANs together, forming a BACnet internetwork. The router shall have optional plug-in boards permitting the following BACnet communication methods:
 - a. The router shall have the routing functionality of interconnecting BACnet Ethernet and/or ARCNET high-speed LAN to BACnet MS/TP LAN and/or more PTP LAN.
 - b. The router shall have the capability of interconnecting BACnet Ethernet high-speed LAN to BACnet ARCNET high-speed LAN.
 - c. BACnet PTP (RS-232 point-to-point) communication shall be available on the global controller by including an (optional) modem. The PTP modem option shall operate under the BACnet half-router communication protocol.
 - d. BACnet messages may be routed to all LANs installed on the router at the same time with no operator intervention.
2. CONVERTER: A converter shall (optionally) be provided to interface an (optional) portable field service computer from its serial port (RS-232) to the BACnet MS/TP LAN (RS-485).
3. REPEATERS: BACnet repeaters shall provide selective interconnection to 4-segments of MS/TP LAN as a minimum. The repeater shall be an active device, containing logic capable of detecting and repeating signals from one MS/TP LAN segment to all other segments. Repeaters shall permit additional nodes to be added to the MS/TP LAN, up to a maximum of 128 nodes.

3.1 GENERAL CONTROLS INSTRUMENTATION

A. Control Panels:

1. Panels shall have hinged doors and be marked with engraved labels. Panels used as a location for mounting control devices shall have a document holder located on the inside of the door.
2. Provide common keying for all panels.
3. Entrance and exit wiring should be on the panel sides.
4. All heat generating devices shall be located at the top of the panel.
5. Combined Temperature and Carbon Dioxide Sensors:
 - a. Where indicated on plans, a combined temperature and carbon dioxide sensor shall be provided in a single package. The combined sensor shall be Telaire Airestat Model 5010 or manufactured by Veris CDW/E series. Housing shall be blank with a momentary pushbutton for override of unoccupied operation. The carbon dioxide sensor shall be non-dispersive infrared type with an accuracy of ± 100 ppm or 7%

of the reading (whichever is greater). Elevation correction adjustment and software for self-correction of drift to better than ± 10 ppm per year shall be incorporated.

- b. Temperature sensors shall be capable of being replaced without the need for controller re-calibration. Temperature sensors shall accordingly have manufactured space temperature and setpoint signal precision tolerances of no greater than 1°F.

6. Temperature Sensors:

- a. All internal temperature sensors for air handler and unit temperature readings shall be temperature averaging cable that spans across the full face of the associated coil. Installation per manufacturer requirements.

B. Labels and Tags:

1. Provide labels for all field devices including sensors, meters, transmitters, and relays. Labels shall be plastic laminate and located adjacent to the device.
2. Labels of field devices (both locally and software ID's) shall be associated with their respective air handler, boiler, chiller, etc.

3.2 ELECTRONIC SENSORS

- C. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required. Thermistor sensing, RTD and transmitter sensing are acceptable for any application.

D. Fan Coil Unit Thermostats and other Thermistor Temperature Sensors (type II) and Transmitters:

1. Accuracy: Plus, or minus 1 deg F at calibration point.
2. Wire: as recommended by building automation system provider.
3. Insertion Elements in Ducts: Single point, length as required by application.
4. Averaging Elements in Ducts: 12 inches.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor: Sensor with lever setpoint adjust, on/override to.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

E. RTDs and Transmitters:

1. Accuracy: Plus, or minus 1 deg F at calibration point.
2. Wire: as recommended by building automation system provider.
3. Insertion Elements in Ducts: Single point, length as required by application.
4. Averaging Elements in Ducts: 12 inches.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor: Space sensor located in public area (corridors, lobby, etc.) shall be metallic wall plate type 2 thermistor with no logo or adjustment dial. Or sensor with setpoint adjust, on/override to match existing.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

F. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 3 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.

3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 0 to 120 degrees.
6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

G. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 1-inch wg
 - d. Duct Static-Pressure Range: 0- to 5-inch wg.
2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and evaluated to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

3.3 STATUS SENSORS

- H. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa). Or current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 120 percent of rated motor current.
- I. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
- J. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 120 percent of rated motor current.
- K. Status of fans, pumps, or motor using current switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- L. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1.2 CO₂, NO₂ and CO sensors

- A. Carbon Dioxide, NO₂ and Carbon Monoxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and factory calibrated, with continuous or averaged reading, 4- to 20-mA output; for wall mounting or duct mounting as required by application.

1.3 AIR FLOW MEASURING STATIONS

- A. Duct Airflow Station: Outside air flow station to be provided by controls contractor.
 - 1. Casing: Galvanized-steel frame.
 - 2. Ebtron thermal dispersment technology type is acceptable.
 - 3. For water flow Onicon flow meter (OR AS NOTED ON PLANS)

1.4 THERMOSTATS

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
 - 1. Label switches ["FAN ON-OFF"].
 - 2. Mount on single electric switch box.
- B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
- C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
 - 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 - 2. Selector Switch: Integral, manual on-off-auto.
- D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from the front of the instrument.
 - 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- E. Fire-Protection Thermostats where shown on plans or points list: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:

1. Reset: Manual.
 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- F. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- G. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-]reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
1. Bulb Length: Minimum 10 feet.
 2. Quantity: As required by application.
- H. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
1. Bulb Length: Minimum 10 feet.
 2. Quantity: As required by application.

1.5 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 2. Actuators on VAV, FCU, UV, Blower coil terminal unit valves failed in place floating signal type.
 3. Non-spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
 5. Non-spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 2. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb./sq. ft. (86.8 kg-cm/sq. m) of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb./sq. ft. (62 kg-cm/sq. m) of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb./sq. ft (49.6 kg-cm/sq. m) of damper.

- d. Opposed-Blade Damper without Edge Seals: 3 inch-lb./sq. ft. (37.2 kg-cm/sq. m) of damper.
 - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 6. Power Requirements (Two-Position Spring Return): 24 V ac.
 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA.
 9. Tri-state: Floating signal.
 10. Temperature Rating: 40 to 104 deg F (5 to 40 deg C).
 11. Run Time: Sized as required for application.

1.6 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
- C. Manufacturers:
 1. Danfoss Inc.; Air Conditioning & Refrigeration Div.
 2. Erie Controls.
 3. Hayward Industrial Products, Inc.
 4. Belimo
- D. Pressure Independent Control Valves
 1. Dynamic control valve shall accurately control flow, independent of system pressure fluctuation. Pressure independent control valves shall be provided on all hot water and chilled water coils for all new and existing air handling units.
 2. Housing shall be constructed of Ductile Iron ASTM A536-65T, Class 60-45-18 rated at no less than 580 psi static pressure.
 3. Valve shall be electronic, dynamic, modulating 2-way control.
 4. Dual pressure/temperature test valves for verifying accuracy of flow performance shall be available for all valve sizes.
 5. The actuator shall be driven by a 24Vdc motor, and shall accept 2-10 Vdc, 4-20mA, 3-point floating or pulse width modulation electric signal and shall include a resistor to facilitate any of these signals.
 6. The actuator shall be capable of providing 4-20mA or 2-10 Vdc feedback signal to the control system.
 7. External LED readout of current valve position and maximum valve position setting shall be standard.
 8. An optional fail-safe system to power valve to either open or closed position from any position in case of power failure shall be available.
 9. Flow regulation unit shall consist of 304 Stainless Steel and hydrogenated acrylonitrile butadiene rubber (1/2"-1-1/2") or 316 Stainless Steel and EPDM (2"-6").
 10. Flow regulation unit shall be accessible for maintenance.

11. Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve.
 12. Close-Off Pressure Rating: 200 PSI.
 13. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
 14. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is not acceptable.
 15. NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent with a P/T port. The return side shall contain a union fitting with a P/T port, pressure independent control valve, an integrated isolation ball valve/manual air vent with a P/T port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited.
- E. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.
 2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 4. Sizing: 3 to 5 psi maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drops, but not more than value specified above.
 5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- F. Butterfly Valves: 200-psig (1380-kPa), maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: Wafer.
 2. Disc Type: Nickel-plated ductile iron.
 3. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.
- G. Terminal Unit Control Valves (VAV, FCU, UV): Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Actuator is floating signal fail in place type.

1.7 DAMPERS

- A. Dampers: AMCA-rated, parallel or opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
 3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
 4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

1.8 CONTROL CABLE

- A. HVAC control systems shall be full DDC. All control wiring in the cable tray shall use purple and yellow colored plenum rated cable. Each color shall be consistent for the entire project and noted on the plans. Blue should be used for the primary network cable and yellow for the secondary network connections.

2.13 CENTRAL PLANT AND AIR HANDLER LOGIC CONTROLLERS

- A. Provide one or more native BACnet logic controllers for each air handler and provide native BACnet logic controllers as needed for central plant control that adequately cover all objects listed in the object list („points list”). Provide spare inputs and outputs on controllers. All controllers shall interface to global controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and a self-contained logic program as needed for complete control of units. Controllers shall be fully programmable. No auxiliary or non-BACnet controllers shall be used.
- B. BACnet Conformance:
1. Logic controllers shall as a minimum support MS/TP BACnet LAN type. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Logic controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
 - a. Files Functional Group
 - b. Reinitialize Functional Group
 - c. Device Communications Functional Group

2. Refer to Section 22.2, BACnet Functional Groups, in the BACnet Standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented, and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
 3. Standard BACnet object types supported shall include as a minimum – Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented, and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- C. Logic controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0-10 VDC, 0-5 VDC, 4-20 mA and dry contact signals. Any input on the controller may be either analog or binary. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display (Alerton Micro set). Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0-10 VDC or 4-20 mA. Software shall include scaling features for analog outputs. Logic controller shall include 24 VDC voltage supplies for use as power supply to external sensors.
- D. All program sequences shall be stored on board the logic controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by the controller a minimum of ten times per second and be capable of multiple PID loops for control of multiple devices. All calculations shall be complete using floating-point math and the system shall support display of all information in floating-point nomenclature at the operator's terminal.
- E. The programming of logic controllers shall be completely modifiable in the field over the installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. The logic controller shall be programmed using programming tools as described in the Operator's Terminal section of this specification.
- F. All programming tools shall be provided as part of the system. Provide documentation in flowchart form of all programming as part of the final system as-built documentation.
- G. Logic controller shall include software-scheduling functions on board without depending on any external device. Scheduling shall be via a BACnet schedule object for seven-day-of-the-week scheduling. The controller shall include interface capability for optional plug-in hardware clock with battery back-up. Provide optional hardware clock as shown on object drawing list included in the Contract Documents (plans or specifications).
- H. Logic controller shall include support for intelligent field sensor (Alerton Micro set). Display on field sensor shall be programmable at logic controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See Sequences of Operation for specific display requirements at intelligent field sensor.

2.14 TERMINAL UNIT CONTROLLERS

- A. Provide one native BACnet programmable logic controller for each piece of unitary mechanical equipment that adequately covers all objects listed in the object list for the unit. All controllers shall interface to the global controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic programs as needed for complete control of the unit.
- B. BACnet Conformance
1. Logic controllers shall as a minimum support MS/TP BACnet LAN type. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps as a native BACnet device. Logic controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
 - a. Files Functional Group
 - b. Reinitialize Functional Group

c. Device Communications Functional Group

2. Refer to Section 22.2, BACnet Functional Groups, in the BACnet Standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented, and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
 3. Standard BACnet object types supported shall include as a minimum – Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented, and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- C. Logic controllers shall include universal inputs with 10-bit resolution and that can accept 3K and 10K thermistors, 0-5 VDC, 4-20 mA and dry contact signals. Any input controller may be either analog or binary. The controller shall also include support and modifiable programming for interface to intelligent room sensor (Alerton Micro set). Controllers shall include binary outputs on board.
- D. All program sequences shall be stored on board the logic controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by the controller ten (10) times per second and shall be capable of multiple PID loops for control of multiple devices.
- E. The programming of logic controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Logic controller shall be programmed using programming tools as described in Operator Terminal section of this specification.
- F. All programming tools shall be provided as a part of the system. Provide documentation in flowchart form of all programming as part of the final system as-built documentation.
- G. Logic controller shall include software-scheduling functions on board without depending on any external device. Scheduling shall be via BACnet schedule object for seven-day-of-the-week scheduling. Controller shall include interface capability for optional plug-in hardware clock with battery backup. Provide optional hardware clock as shown on the object list included with the Contract Documents (plans and specifications).
- H. Logic controller shall include support for intelligent field sensor (Alerton Micro set). Display on field sensor shall be programmable at logic controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See Sequence of Operation for specific display requirements at intelligent field sensor.

PART 3 – EXECUTION

3.1 TRAINING

- A. The Controls Contractor shall provide complete on-site training for the Owner's designated operating personnel. Training shall include all functional aspects of the control system and all modes of system operation. System modes include occupied/unoccupied, heating/cooling, economizer, startup/shutdown, energy management, and alarm event operations. Training of Owner's operating personnel shall include a minimum of eight (8) hours of system instruction, conducted during one or two site visits for a combined total of eight hours of instruction. Additional instruction time may be requested by the Owner for an additional fee if needed for training additional personnel or if more instruction is requested. Training is not intended to include in-depth instruction in system programming.

- B. Training shall be conducted during normal working hours, Monday through Friday, at the project site. If applicable, the training may be conducted at the Owner's central energy management office in addition to the training on site.

- C. The contractor shall furnish one (1) copy of the system Operator's Manual to the Owner. This manual should be delivered to the Owner at the time of training. This manual is in addition to the system As-built documents which are intended to show wiring configurations and sensor locations.

SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.

C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.

D. 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.

1.3 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.

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. 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.

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. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

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.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and 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 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

2.5 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 2 and smaller.
- B. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Body and Diaphragm Case: Die-cast aluminum.
 2. Springs: Zinc-plated steel; interchangeable.
 3. Diaphragm Plate: Zinc-plated steel.
 4. Seat Disc: Nitrile rubber.
 5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 7. Regulator vent limiting device.
 8. Maximum Inlet Pressure: 2 psig.

2.6 DIELECTRIC UNIONS

- A. Minimum Operating-Pressure Rating: 150 psig.
- B. Combination fitting of copper alloy and ferrous materials.
- C. Insulating materials suitable for natural gas.
- D. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

2.8 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

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 inches wide and 4 mils thick, 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 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and 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 Division 31 Section "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. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. 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.
- E. Install fittings for changes in direction and branch connections.
- F. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install them in an annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.2 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and 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 pipes and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange 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. 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 in Division 07 Section "Penetration Firestopping."
- L. Verify final equipment locations for roughing-in.
- M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptiness. 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 it with space below bottom of drip to remove plug or cap.

- O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- P. 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.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.
- T. Do not use natural-gas piping as grounding electrode.

3.3 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install earthquake valves aboveground outside buildings according to listing.

3.4 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 dryseal 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. Flared Joints: Cut tubing with roll cutting tool. The flare tube ends with a tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. 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.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and 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.

3.6 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 view of each gas-fired appliance and equipment (72" max). 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.

3.7 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 23 11 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-407C:
 - 1. Suction Lines for Air-Conditioning Applications: 230 psig.
 - 2. Suction Lines for Heat-Pump Applications: 380 psig.
 - 3. Hot-Gas and Liquid Lines: 380 psig.
- B. 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.

1.3 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.4 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.

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.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. 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.

- E. 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.
- F. 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.
- G. 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 .
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 450 psig
- H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- J. 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.
- K. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 microns, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Rated Flow: as indicated on the drawings.
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 240 deg F.
- L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 microns, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS ¼ connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Rated Flow: tons as indicated on the drawings.
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 240 deg F.
- M. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 1-1/2 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing, and wrought-copper fittings with brazed or soldered joints.
 - 4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- G. Safety-Relief-Valve Discharge Piping:
 - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 1-1/2 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing, and wrought-copper fittings with brazed or soldered joints.
 - 4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. 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 a connection where it will reflect suction-line pressure at bulb location.
- H. Installing safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. 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.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 1. Solenoid valves.
 2. Thermostatic expansion valves.
 3. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- L. Install flexible connectors at compressors.

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 in accordance with the equipment manufacturer's recommendations.
- C. Install refrigerant piping according to ASHRAE 15.
- 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. Install piping adjacent to machines to allow service and maintenance.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- 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 Division 08 Section "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 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 pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. 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 BA_g, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or 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.
- B. 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

C. Support multifloored 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 and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Evaluate 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 the system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Evaluate 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 the vacuum holds for 12 hours, the 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 controllers to the system design temperature.

- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Verify that compressor oil level is correct.
 2. Open compressor suction and discharge valves.
 3. Open refrigerant valves except bypass valves that are used for other purposes.
 4. 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. Double-wall round ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

- B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "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 and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
1. Liners and adhesives.
 2. Sealants and gaskets.
 3. Seismic-restraint devices.
- 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 the 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, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- D. 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. Penetration 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.
- E. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- 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 D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, 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 1-4, "Transverse (Girth) 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 1-5, "Longitudinal Seams - Rectangular Ducts," 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 2, "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.
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:
 - a. Lindab Inc.
 - b. McGill Airflow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
 - f. Hamlin
- 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 3-2, "Transverse Joints - Round Duct," 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 3-1, "Seams - Round Duct and Fittings," 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. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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 DOUBLE-WALL ROUND DUCTS AND 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:

1. Lindab Inc.
 2. McGill Airflow LLC.
 3. SEMCO Incorporated.
 4. Sheet Metal Connectors, Inc.
- 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) of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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."
- D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.

- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2.4 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. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. 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.
- 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.

2.5 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when evaluated according to UL 723; certified by an NRTL.

3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 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 2-19, "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 nosing's 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. 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.

2.6 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 evaluated according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 9. VOC: Maximum 395 g/L.
 10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 11. Service: Indoor or outdoor.

12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. 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.
 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 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 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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 the 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 the 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, fire dampers. Comply with requirements in Division 23 Section "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 "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 the 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 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."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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 interval 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.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
1. Identify the position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeves fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "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 Division 09 painting Sections.

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. Evaluate the following systems:
 - a. All medium pressure supply mains from built-up Air Handling Units to the terminal box connections.
 - b. Low pressure supply ducts (single zone units and supply ductwork downstream of terminal boxes): Test representative duct sections, totaling no less than 10 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. Evaluate leaks before applying external insulation.
 5. Conduct tests at static pressures equal to maximum design pressure of system or section being evaluated. If static-pressure classes are not indicated, evaluate the 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 Cleanliness Tests:
 1. Visually inspect the duct system to ensure that no visible contaminants are present.

2. Evaluate sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined ducts. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use a filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coils drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel unless noted otherwise.
- B. Supply Ducts:
 1. Ducts Connected to Indoor Units and Packaged Heat Pumps:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- C. Return Ducts:
 1. Ducts Connected to Indoor Units and Packaged Heat Pumps:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.

- c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- D. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 3-inch wg, or as applicable for fan static pressure listed in schedules.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Indoor Units or Packaged Heat Pumps:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
 - 2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum.

G. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1 inch thick.

2. Return Air Ducts: 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "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 2-3, "Vanes and Vane Runners," and Figure 2-4, "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 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "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.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - 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 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing ducts.
 - 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. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Flange connectors.
7. Duct silencers.
8. Turning vanes.
9. Remote damper operators.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.
14. Airflow Monitoring Stations

- B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1. For duct silencers, 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.
- C. Source quality-control reports.
- D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- 1.4 QUALITY ASSURANCE
- 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 AMCA 500-D testing for damper rating.
- 1.5 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. 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: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.
- D. 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.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

- G. 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.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff; a division of PCI Industries, Inc.
 - 6. Ruskin Company.
 - 7. SEMCO Incorporated.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1500 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Maximum Leakage: 40" wide, 1% of max. flow.
- F. Frame: 0.09-inch- thick extruded aluminum, with welded corners.
- G. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.
- H. Blade Action: Parallel.
- I. Blade Seals: Extruded vinyl, mechanically locked.
- J. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.20 inch.
- K. Tie Bars and Brackets: Aluminum.
- L. Return Spring: Adjustable tension.
- M. Bearings: Steel ball or synthetic pivot bushings.
- N. Accessories: (as noted on plans or required by installation)
 - 1. Electric actuators.
 - 2. Chain pulls.
 - 3. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 4. Screen Mounting: Rear mounted.

5. Screen Material: Aluminum.
6. Screen Type: Bird or Insect (as noted on drawings)
7. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. American Warming and Ventilating; a division of Mestek, Inc.
 3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Pottorff; a division of PCI Industries, Inc.
 6. Ruskin Company.
 7. SEMCO Incorporated.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Maximum Leakage: 40" wide, 1% of max. flow.
- F. Frame: 0.09-inch- thick extruded aluminum, with welded corners.
- G. Blades:
1. Multiple, 0.025-inch- thick, roll-formed aluminum.
 2. Maximum Width: 2 inches.
 3. Action: Parallel.
 4. Balance: Gravity.
 5. Eccentrically pivoted.
- H. Blade Seals: Vinyl.
- I. Blade Axles: ½" diameter synthetic
- J. Tie Bars and Brackets:
1. Material: Aluminum.
 2. Rattle free with 90-degree stop.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic.
- M. Accessories: (as noted on plans or required by installation)
1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits for vertical airflow installations.
 3. Flange on intake.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
2. Suitable for horizontal or vertical applications.
3. Frames:
 - a. Hat-shaped, galvanized-steel channels, 16-gauge minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 16-gauge thick.
5. Blade Axles: Galvanized steel.
6. Bearings:
 - a. Molded synthetic.
 - b. 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.
7. Tie Bars and Brackets: Galvanized steel.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. METALAIRE, Inc.
4. Metal Form Manufacturing, Inc.
5. Nailor Industries Inc.
6. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

D. Blades:

1. Multiple blades with maximum blade width of 8 inches, airfoil design.
2. Opposed-blade design.
3. Galvanized steel.
4. 14-gauge thickness.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized 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.

F. Bearings:

1. 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:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff; a division of PCI Industries, Inc.
5. NCA Manufacturing.
6. Ruskin Company.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 20-gauge galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch 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, 0.034-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 (unless noted otherwise).

2.7 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 30 inches wide and double wall for larger dimensions.

2.8 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pottorff; a division of PCI Industries, Inc.
 - 2. Ventfabrics, Inc.
 - 3. Young Regulator Company.
 - 4. Metropolitan.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed, 3/4 inches deep.
- F. Wall-Box Cover-Plate Material: Stainless steel.

2.9 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Ductmate Industries, Inc.
 3. Greenheck Fan Corporation.
 4. McGill AirFlow LLC.
 5. Nailor Industries Inc.
 6. Pottorff; a division of PCI Industries, Inc.
 7. Ruskin
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fills and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - d. Fabricated 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.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Single wall, 12-gauge.
 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 4. Factory set at 2" to 10" for positive pressure and -4" to -10" for negative pressure.
 5. Doors close when pressures are within set-point range.
 6. Hinge: Continuous piano.
 7. Latches: Cam.
 8. Seal: Neoprene or foam rubber.
 9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 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 3-1/2 inches wide attached to 2 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. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd.
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd.
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. 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-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Non insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 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.
- C. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized 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 20 to plus 250 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2007.
- D. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or nylon strap in sizes 3 through 18 inches, to suit duct size.

2.12 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.

2.13 AIRFLOW MONITORING STATIONS

- A. Air Measuring Stations to be furnished under this section of specification and installed under Division 23 Section. Provide, where indicated and scheduled, an airflow measuring element assembly capable of continuously monitoring the airflow capacity in the duct.
1. The airflow sensing elements shall be constructed of 6000 Series extruded aluminum, forming two (2) integral chambers for Total and Static pressure averaging, without the physical presence of forward projecting sensors. Individual Total and Static pressure sensing elements are not acceptable.
 2. The number of sensing ports on each element, and the quantity of elements utilized at each installation, shall comply with the ASHRAE Standard #111 for duct traversing. The airflow traverse elements shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without amplification nor flow correction (K factors), or field calibration, with an accuracy of 2% of actual flow for operating velocities as low as 100 feet per minute.
 3. The airflow elements shall not induce a pressure drop greater than .03" Water Column at 2000 FPM, nor shall the sound level within the duct be amplified by its presence in the air stream. Each airflow measuring element shall contain multiple Total and Static pressure sensors.
 4. Where primary flow elements are located outside of the manufacturers published installation guidelines the manufacturer shall be consulted, and approve of any special configurations, such as air equalizers and/or additional and strategically placed measuring points as may be required.

5. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inches to three inches to facilitate matching connecting ductwork.
 6. The main take-off point from both the total pressure and the static pressure elements MUST be symmetrical. The probes shall be mounted in an eight-inch deep, 16-gauge galvanized steel casing with 90-degree undrilled flanges, fabricated to the duct size, and shall contain multiple airflow traverse elements interconnected as herein before described.
 7. An identification label shall be placed on each element listing the Model No., System Served, Size and Identifying Tag Number.
 8. The airflow measuring element shall be by Ebtron (or approval equal).
- B. Airflow Indicating Transducers to be furnished and installed under this section of the specification.
1. Provide individual airflow transducers, especially selected for the required design operating spans of each of the above primary elements.
 2. The electronic flow transducer(s) shall be solid-state analog type, with infinite resolution to facilitate volume tracking control functions. Microprocessor based transducers with time-sharing of multiple square root extractors and/or controllers are not acceptable.
 3. The transducer(s) shall be housed in a NEMA 1 enclosure with integral terminal strip for field wiring, and power and output signal conduit connection port.
 4. Each transducer=s output shall not be affected by direction of mounting (attitude) or external vibrations and shall be furnished with a factory calibrated span. The analog output signal shall be linear to air volume, which is factory set for a full-scale value equal to 110% of the maximum design capacity of the flow measuring element served for variable air volume applications, or 200% of the design operating value for constant volume applications.
 5. Electronic transducers shall operate on 16 to 36 VDC: Transducer(s) shall have outputs of 4 to 20 mA/2-wire or 0-10VDC/3-wire.
 6. Each transducer shall be provided with a local indicating meter. The local digital indicating meter shall be one half-inch high, three- and one-half digit liquid crystal display (LCD) type. The LCD shall indicate the measured air volume in engineering units of cubic feet per minute (CFM). The meter shall be calibrated to an accuracy of + 1 count.
 7. Transducer performance shall be equal or better than the following:
 - Hysteresis: +0.05%
 - Linearity: +0.4%
 - Repeatability: +0.1%
 - Temperature Effects: <+0.03% F.S./°F
 - Over-pressure: 5 PSIG Proof
 - Response: <0.25 seconds for full span input
 - Noise Filtration: Low Pass Filter, factory set @ 3.2Hz

Transducer Span: < 2 times the design velocity pressure @ maximum flow
Accuracy: +0.5% F.S. (Terminal Point) / +0.35% F.S. (BFSL)

8. The airflow indicating transducers shall be the FIT-1001D as manufactured by Ebtron (or approval equal).

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 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 and smoke dampers according to UL listing and manufacturer's instructions.
- H. Connect ducts to duct silencers with flexible duct connectors.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream from duct filters.
 3. drain pans and seals.
 4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 5. 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.
 6. Control devices requiring inspection.
 7. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 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 directly or with maximum 6-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts with maximum 48-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with approved strap and sealant.

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-inch movement 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 the 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.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 23 - HVAC POWER 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.
- B. See fan schedule on drawings for additional requirements and specific options required for each fan.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.
 - 2. Ceiling-mounting ventilators.
 - 3. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACCEPTABLE MANUFACTURERS

- A. Listing manufacturers' name does not guarantee approval. All equipment must meet or exceed the quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid on this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housing, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, wiring diagrams, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- C. Operation and Maintenance Data: For power ventilators to include operation and maintenance manuals.

1.6 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolts inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector for UL 762 kitchen hood exhaust fans.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- E. Accessories: (See drawings for required accessories).
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Backdraft dampers on all roof mounted supply fans shall be motorized.
- F. Roof Curbs: Galvanized steel; 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 suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall, Height: 8 inches (unless noted otherwise).
 - 3. Pitch Mounting: Manufacture curb for roof slope.
 - 4. Metal Liner: Galvanized steel.
 - 5. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares (where indicated in the drawings).
 - 6. Vented Curb: Unlined with louvered vents in vertical sides (where indicated on the drawings).
- G. Capacities and Characteristics: As indicated on the drawings.

2.2 CEILING-MOUNTING VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories: (See drawings for required accessories).

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. Capacities and Characteristics: As indicated on the drawings.

2.3 IN-LINE CENTRIFUGAL FANS

- A. Description: In-line, direct- or belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. Housing: Split spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Driven Units: Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 3. Companion Flanges: For inlet and outlet duct connections.
 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 5. Motor and Drive Cover (Belt Guard): Galvanized steel.
- G. Capacities and Characteristics: As indicated on the drawings.

2.5 MOTORS

- a. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- a. Enclosure Type: Totally enclosed, fan cooled.

2.6 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, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Evaluate and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 34 23

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. Perforated diffusers.
 - 3. Louver face diffusers.
 - 4. Linear bar diffusers.
 - 5. Linear slot diffusers.
 - 6. Linear bar grilles.
- B. Related Sections:
 - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACCEPTABLE MANUFACTURERS

- A. Listing manufacturers' name does not guarantee approval. All equipment must meet or exceed the quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid on this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.4 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.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

- D. 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. Ceiling suspension assembly members.
 2. Method of attaching hangers to building structure.
 3. Size and location of initial access modules for acoustical tile.
 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 5. Duct access panels.
- E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers:
1. Devices shall be specifically designed for variable-air-volume flows.
 2. Material: Steel or Aluminum as indicated on the drawings.
 3. Finish: Baked enamel, white unless noted otherwise.
 4. Face Size: 24 by 24 inches or as indicated on the drawings.
 5. Face Style: Four cones.
 6. Mounting: As required.
 7. Pattern: Fixed.
 8. Dampers: Radial opposed blade.
- B. Perforated Diffuser:
1. Devices shall be specifically designed for variable-air-volume flows.
 2. Material: Steel backpan and pattern controllers, with steel or aluminum face as indicated on the drawings.
 3. Finish: Baked enamel, white unless noted otherwise.
 4. Face Size: 24 by 24 inches or as indicated on the drawings.
 5. Duct Inlet: Round or Square as indicated on the drawings.
 6. Face Style: Flush.
 7. Mounting: T-bar.
 8. Pattern Controller: Adjustable with louvered pattern modules at inlet.
 9. Dampers: Radial opposed blade.
- C. Louver Face Diffuser:
1. Devices shall be specifically designed for variable-air-volume flows.
 2. Material: Steel or Aluminum as indicated on the drawings.
 3. Finish: Baked enamel, white unless noted otherwise.
 4. Face Size: As indicated on the drawings.
 5. Mounting: As required.
 6. Pattern: Four-way core style, unless noted otherwise.
 7. Dampers: Radial opposed blade.

2.2 REGISTERS AND GRILLES

A. Linear Bar Grille:

1. Material: Aluminum.
2. Finish: Baked enamel, white unless noted otherwise.
3. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
4. Distribution plenum.
 - a. Internal insulation.
 - b. Inlet damper.
5. Frame: 1-1/4 inches wide.
6. Mounting: Concealed.
7. Damper Type: Adjustable opposed blade.

2.3 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material - Shell: Steel or Aluminum as indicated on the drawings.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel, white exterior with black interior, unless noted otherwise.
5. Finish - Pattern Controller: Baked enamel, black.
6. Finish - Tees: Baked enamel, white.
7. Slot Width: As indicated on the drawings.
8. Number of Slots: as indicated on the drawings.
9. Length: as indicated on the drawings.
10. Accessories:
 - a. End caps in lay-in ceilings.
 - b. End Borders where not installed in lay-in ceilings.
 - c. Insulated plenum: By manufacturer black finish unless otherwise noted.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

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 73 23 - ROOFTOP UNITS

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 packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Economizer outdoor- and return-air damper section.
 - 3. Roof curbs.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- D. Supply-Air Fan: The fan provides supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- 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.

- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 3. Comply with applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. 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.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Provide a full parts & labor warranty (by manufacturer) for 12 months from the date of startup or 18 months from the date of shipment whichever occurs first.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than 36 months from date of startup or 42 months from date of shipment, whichever occurs first.
 - 3. Warranty Period for Compressors: Manufacturer's standard, but not less than 60 months from date of startup or 66 months from date of shipment, whichever occurs first.

PART 2 - PRODUCTS

2.1 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced single wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Unit shall be single piece construction as manufactured at the factory. Site assembly sub-assemblies will not be allowed. Package units shall be constructed for installation on a roof curb providing full perimeter support under the air handler section and pedestal support under condenser section.
- C. Cabinet: Galvanized steel, phosphatized, and finished with an air-dry paint coating durable enough to withstand 1000 consecutive-hour salt spray application in accordance with standard ASTM B 117. Structural members shall be 14 gauge with access doors and removable panels of minimum 18-gauge steel. Roof panels shall be sloped to provide positive drainage of rainwater / melting snow away from the cabinet.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Thickness: ½ inch
 - 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating.
 - 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1-2007.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple.
 - 3. Pan-Top Surface Coating: Corrosion-resistant compound.
 - 4. Drains shall be sloped to insure drainage.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.
- G. Unit shall have a leakproof casing, be corrosion resistant (ASTM B117 Standard), and shall be equipped with metal grid frames for media filter material. Filter efficiency shall be per ASHRAE 52.
- H. Control Panel: The unit control panel section shall be compartmented to separate high and low voltage components. The control panels shall also be fully gasketed, hinged and provided with quick release latches for easy access.
- I. Access Doors: Fully gasketed hinged doors with fluted knob fasteners and chained "tie-backs" to provide access to filters, heating section, return/exhaust air fan section, supply air fan section and evaporator coil section.
- J. RTU shall have louvered grilles to protect coils from hail damage or vandalism.

2.2 FANS

- A. Supply fan shall be [one] [two] single width, single inlet 9-blade plenum fan. Fan blades shall be aluminum backward-inclined airfoil. Plenum fans shall be direct-driven. The entire assembly shall be completely isolated from unit and fan board by 2-inch deflection spring isolation. Multiple fan widths shall be available to optimize efficiency. Fans shall not require routine maintenance such as fan bearing lubrication, belt tensioning and replacement, sheave alignment, and setscrew torque checks.
- B. Provide forward curved exhaust fans with fixed-pitch sheave drive assemblies. Dynamically balance all fans and the unit's running fan assembly (fan mounted on actual shaft, bearings, and in scroll housing) to assure smooth operation of the fan and its associated assembly. Balancing of the fan only shall not be acceptable.
- C. Mount fan motor(s) and fan on a common base assembly and isolated from unit with double deflection rubber-in-shear isolators. Provide thrust restraint isolation on the fan housing/fan board to assure smooth fan startup transition and operation.
- D. Fan shaft shall be mounted on grease lubricated ball bearings.
- E. Motor shall be open drip-proof. Motor shall have a standard T-frame and a minimum service factor of 1.15. All drive components shall be accessible without the use of scaffolds or ladders, to facilitate periodic maintenance checks and for operator safety.
- F. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Provide heavy duty aluminum fins mechanically bonded to copper tubes. Evaporator coil shall be inter-circuited to maintain active coil face area at part load conditions. Coil shall also utilize internally enhanced tubing for maximum efficiency.
 - 2. Provide a thermostatic expansion valve (TXV) for each refrigerant circuit. Factory pressure and leak test coil at 300 psi.
 - 3. Condensate Drain Pan: Provide pitched stainless-steel drain pan to assure positive drainage of condensate from the unit casing.
- B. Air-cooled Condenser Section
 - 1. Condenser coils shall have all Aluminum Microchannel coils. All coils shall be leak evaluated at the factory to ensure pressure integrity. The condenser coil is pressure evaluated to 650 psig. Subcooling circuit(s) shall be provided as standard.
 - 2. Provide subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant, to a gaseous state, ahead of the expansion valve.
 - 3. Provide vertical discharge, direct drive fans with steel blades, and three phase motors. Fans shall be statically and dynamically balanced. Motors shall be permanently lubricated, with built-in current and thermal overload protection and weathertight slinger over motor bearings.

4. Provide factory installed louvered steel coil guards around perimeter of condensing section to protect the condenser coils, refrigerant piping, and control components. Louvered panels shall be fabricated from heavy gauge galvanized steel and be rigid enough to provide permanent protection for shipping and pre-/post- installation. Course wire mesh is not an acceptable material for coil guards.

2.4 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor

1. Shall be industrial grade, energy efficient direct drive 3600 RPM maximum speed reciprocating or scroll type. The motor shall be of a suction gas cooled hermetic design. The compressor shall have a centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve.
2. Provide with thermostatic motor winding temperature control to protect against excessive motor temperatures resulting from over-/under-voltage or loss of charge. Provide high- and low-pressure cutouts and reset relay.
3. Provide factory-installed compressor lockout thermostat to prevent compressor operation at low ambient conditions.
4. Provide coil frost protection compressor unloading based on refrigerant circuit suction temperature to prevent coil frosting with minimum energy usage. As an alternative, factory-installed hot gas bypass shall be required on all VAV units to prevent coil frosting.

B. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
11. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves (Alco or Sporlan), and a suction line accumulator.
12. Coil frost protection.

2.5 HEATING COILS

- A. Certification: Acceptable refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. The manufacturer must be ISO 9002 certified.

- B. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not, factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
- C. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
- D. Fins shall have a minimum thickness of 0.0075-inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
- E. Coil tubes shall be 5/8-inch OD seamless copper, 0.020-inch nominal tube wall thickness, expanded into fins, brazed at joints. Soldered U-bends shall be provided to minimize the effects of erosion and premature failure having a minimum tube wall thickness of .025 inches.
- F. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections are provided at the highest point to ensure proper venting. Drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.
- G. Coil casing shall be a formed channel frame of stainless steel.

2.6 EXHAUST SECTION

- A. 100 Percent Modulating Exhaust Fan
 - 1. The 100 percent modulating relief damper shall be modulated in response to building pressure. A differential pressure control system shall use a differential pressure transducer to compare indoor building pressure to outdoor ambient atmospheric pressure. The control system shall modulate the discharge dampers to control the building pressure to within the adjustable, specified dead band that shall be adjustable at the Human Interface Panel. The exhaust fan VFD shall modulate in response to return duct static pressure.

2.7 OUTDOOR AIR SECTION

- A. Provide 100% modulating comparative enthalpy-based economizer system fully integrated with unit return and exhaust air dampers. Unit operation is through primary temperature controls that automatically modulate dampers to maintain desired space temperature conditions.

2.8 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - 1. Damper Motor: Modulating with adjustable minimum position.
 - 2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1-2007, with bird screen and hood.

2.9 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and 230993 "Sequence of Operations for HVAC Controls."
- B. General - Each unit shall be provided with a factory-installed, programmed and run-tested, stand-alone, microprocessor control system suitable for CV or VAV control as required. This system shall consist of temperature and pressure (thermistor and transducer) sensors, printed circuit boards, and a unit-mounted Human Interface Panel. The microprocessor shall be equipped with on-board diagnostics to indicate that all hardware, software, and all interconnected wiring and sensors are in proper operating condition. The microprocessor's memory shall be non-volatile EEPROM type, thus requiring no battery or capacitive backup to maintain all data during a power loss
Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
- C. The Human Interface Panel shall be readily accessible for service diagnosis and programming without having to open the main control panel on the rooftop unit. Alphanumeric coded displays shall not be acceptable.
 - 1. Human Interface (HI) Panel - shall be a 16 key touch-sensitive membrane key switch panel, password protected to prevent use by unauthorized personnel. The Human Interface Panel display shall consist of a 2 line by 40 characters per line clear English display. The display shall be Supertwist Liquid Crystal Display (LCD) with blue characters, 5 X 7 dot matrix with cursor, on a gray-green background for high visibility and reading ease.
- D. Anti-recycle Protection - shall be provided to prevent excessive cycling, and premature wear, of the compressors, contactors, and related components.

2.10 BUILDING MANAGEMENT SYSTEM

- A. Control Functions: Includes unit time scheduling, occupied/unoccupied mode, optimal start/stop, night-time free-cooling purge mode, two-step demand limiting, night setback, morning warm up, discharge air set point adjustment, universal smoke purge, building pressurization, timed override, and alarm shutdown.
- B. Diagnostic Functions: Shall include:
1. RTM temp sensor fail.
 2. Heat failure.
 3. Supply air temp sensor fail.
 4. Unocc zone cool stpt fail.
 5. RTM auxiliary temp sensor fail.
 6. Unocc zone heat stpt fail.
 7. OA temp sensor failure
 8. Supply sir press stpt fail.
 9. Mode input failure
 10. Spc static press stpt fail.
 11. Occ zone cool setpoint fail.
 12. Space press sensor fail.
 13. Occ zone heat setpoint fail.
 14. Return air temp sensor fail.
 15. Supply air pressure sensor fail.
 16. RA humidity sensor fail.
 17. OA humidity sensor fail.
 18. Supply air static press limit.
 19. Emergency stop
 20. SCM communications fail.
 21. Supply fan fail.
 22. MCM communications fail.
 23. Exhaust fan fail.
 24. Heat module comm fail.
 25. Evap temp sensor fail.
 26. ECEM communications fail.
 27. Evap temp sensor fail - Ckt 1
 28. Evap temp sensor fail - Ckt 2
 29. GBAS module comm fail.
 30. TCI module comm fail.
 31. Low press control open
 32. Low press control open - Ckt 1
 33. Low press control open - Ckt 2
 34. Tracer communications fail.
 35. NSB panel communications
 36. Remote HI communications fail.
 37. Cond temp sensor fail.
 38. Cond temp sensor fail - Ckt 1
 39. Cond temp sensor fail - Ckt 2
 40. Unit HI communications fail.
 41. VOM communications fail.
 42. Compressor contactor fail.
 43. Comp. contactor fail - Ckt 1
 44. Comp. contactor fail - Ckt 2
 45. Compressor trip
 46. Compressor trip - Ckt 1

47. Compressor trip - Ckt 2
48. Supply air temp cool stpt fail.
49. Supply air temp heat stpt fail.
50. Morning warmup zone sensor fail.
51. Freeze stat trip.
52. Dirty filter
53. NSB panel zone temp sensor fail.

2.11 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Hail guards of galvanized steel, painted to match casing.

2.12 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1 inch.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 14 inches, coordinate with roofing insulation height and slope.

2.13 CAPACITIES AND CHARACTERISTICS

1. See plans for capacities and characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. **Roof Curb:** Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- B. **Unit Support:** Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and spill over concrete splash block.
- B. Install piping adjacent to RTUs to allow service and maintenance.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to terminate at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under the entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.
 - 5. Install concrete mix inside roof curb. Concrete, formwork, and reinforcement are specified in Division 03.

3.4 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, evaluate, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

- B. Perform tests and inspections and prepare test reports.
 - 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. Report results in writing.
 - 2. Local factory service shall be available within four hours. Additionally, a local factory controls technician for the rooftop equipment shall coordinate with the EMS contractor for integration.
- C. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Evaluate and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Recommended spare parts list shall be submitted by the manufacturer.

3.5 STARTUP SERVICE

- A. Startup services for each unit to be supplied by the unit manufacturer. Start-up technician must be an employee of the equipment manufacturer.
- B. Complete installation and startup check according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean condenser coil and inspect for construction debris.
 - 10. Clean furnace flue and inspect for construction debris.
 - 11. Connect and purge gas line.
 - 12. Remove packing from vibration isolators.
 - 13. Inspect operation of barometric relief dampers.
 - 14. Verify lubrication on fan and motor bearings.
 - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 16. Adjust fan belts to proper alignment and tension.
 - 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.

- c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Inspect operation of power vents.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressures differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and fire stat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 73 23

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ductless split-system air-conditioning and condensing units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting.

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.
- B. Operation and maintenance data.

1.3 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 Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

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, but are not limited to, the following:

2.2 EVAPORATOR-FAN UNIT

- A. Concealed Unit Chassis and or Ceiling Cassette: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 1. Insulation: Faced, glass-fiber duct liner.
 - 2. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1-2007.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
- D. Fan Motor: Multispeed.
- E. Filters: 1 inch thick, in fiberboard frames.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

- A. Casing steel, finished with baked enamel, 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.
- B. Compressor: Hermetically sealed reciprocating type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Refrigerant: R-410a (unless otherwise indicated in the drawings).
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Fan: Aluminum-propeller type, directly connected to motor.
- E. Motor: Permanently lubricated, with integral thermal-overload protection.
- F. Low Ambient Kit: Permits operation down to 0 deg F.
- G. Mounting Base: Polyethylene.
- H. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2007, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Outdoor air connection kit

- C. 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.
 - 1. Minimum Insulation Thickness: 1/2 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- B. Install ground-mounted, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- D. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- B. Connect supply and return condenser 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.
- C. Install piping adjacent to the unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, evaluate, and adjust field-assembled components and equipment installation, including connection, and to assist in field testing. Report results in writing.
- B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace them with new components, and retest.

- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 81 26

Division 26 – Electrical

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 GENERAL

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. All free-standing electrical equipment such as switchboards, motor control centers, transformers, generators, etc., shall be mounted on 4inch housekeeping pads mechanically connected to the structural floor.
- C. Conductors serving two separate power systems (i.e., 120/208 V and 277/480 V) shall not be mixed in the same raceway, pull box, or junction box. The exception is where the control wiring is a different voltage than the power.
- D. Conductors feeding lighting outlets shall not be combined in the same raceway with conduit serving convenience receptacles. Lighting outlets and convenience receptacles shall not be connected on the same circuit unless specifically intended.
- E. Boxes and devices installed in suspended ceilings are to be supported to the grid with an independent support wire to structure.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.
 - 6. Thermographic Imaging.
 - 7. Acoustic treatment where acoustical batt is used.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. Connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- E. Coordinate acoustical treatments for electrical devices, boxes, conduit, etc. with architectural wall schedule for acoustical details where acoustical batt is present.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
- c. Metraflex Co.
- d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetration unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetration of concrete and masonry.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use 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 them in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 Thermographic Imaging

A. Thermographic imaging survey shall be required for the following equipment installations:

1. Medium Voltage Cable terminations.
2. Pad Mount Transformer connections (primary and secondary).
3. Service Entrance Switchboard Connections.
4. Emergency Generator Connections.
5. Automatic Transfer Switch Connections.

B. The thermographic imaging survey shall be performed by a thermographic imaging contractor who is a level III certified Thermographer and who has received accreditation through a NETA accredited Thermography training program. The imaging contractor shall have an equipment calibration program that is traceable to the National Institute of Standards and Technology (NIST). Imaging equipment must be calibrated within the last six months. Imaging equipment shall include a Forward-Looking InfraRed camera able to detect emitted thermal infrared radiation and convert the detected emissions into a visual image. The imaging contractor shall provide a test report to the engineer and owner. Deficiencies shall be addressed by the Electrical Contractor.

3.6 Required Inspections

A. It shall be the responsibility of the electrical contractor to notify the Office of the State Electrical Inspector at the State Construction Office to schedule required inspections including rough-in, above ceiling and final inspections.

3.7 INFORMATION MODELING

A. Electrical contractor shall be responsible for providing the final coordination model (electrical items) to the owner that meets all applicable formatting and documentation requirements as noted in the latest version of the UNC Charlotte bim/vdc requirements implementation plan. Items that shall be provided include but are not limited to input of associated equipment model numbers, serial numbers, tracking data asset tags, etc.

END OF SECTION 26 05 00

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1. All wire and cable shall be listed by an "approved" third-party testing agency.
2. Prior to energizing feeders, sub-feeders and service conductor cables shall be evaluated for electrical continuity and short circuits. A copy of these tests shall be sent to the State Construction Office, the engineer of record, and the owner.
3. Individual neutral wire shall be provided for each branch circuit feeding electronic equipment. Shared neutrals will not be accepted.
4. All wire shall be new, manufactured within the last six months.
5. MC cable is NOT allowed.

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. Building wires and cables rated 600 V or less.
 2. Connectors, splices, and terminations rated 600 V or less.
 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. 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.
- 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 NFPA 70.

1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Aluminum conductors are not allowed.
- D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- E. Power and lighting circuits' minimum conductor size shall be #12 AWG, and maximum conductor size allowed shall be 500 Kcmil.
- F. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drop on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).
- G. Power and lighting circuits #10 AWG and smaller shall have solid copper conductors. Conductor sizes #8 AWG and larger shall have Class B stranded copper conductors.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

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.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- I. Branch Circuits Installed Below Raised Flooring: Type THHN-THWN, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- L. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes Power-limited tray cable, in cable tray.
- M. The power and lighting circuits' minimum conductor size shall be #12 AWG copper.
- N. The maximum conductor size shall be 500 kcmil.
- O. An individual neutral wire is required for each circuit.
- P. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drops on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).
- Q. Where the conductor length from the panel to the first outlet on a 277-volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.

- R. Where the conductor length from the panel to the first outlet on a 120-volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. 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.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

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 and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both wall surfaces.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

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 Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
 - 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. Infrared Scanning: After Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
- D. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Completion.
- E. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- F. 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.
- G. Evaluate Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.9 FEEDER INSULATION RESISTANCE TESTING

- A. All current carrying phase conductors and neutrals shall be evaluated as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500-volt megger. The procedures listed below shall be followed:
 - 1. Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor.
 - 2. After all fixtures, devices and equipment are installed and all connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then evaluate each one separately on the panel and until the low readings are found. The contractor shall correct troubles, reconnect, and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
 - 3. At final inspection, the contractor shall furnish a megger and show the engineers and State Construction Office representatives that the panels comply with the above requirements. He shall also furnish a hook-on type of ammeter and voltmeter to take current and voltage readings as directed by the representatives.

END OF SECTION 26 05 19

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 Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Overhead-lines grounding.
 - 2. Underground distribution grounding.
 - 3. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.
- F. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.4 QUALITY ASSURANCE

- A. 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 to supervise on-site testing specified in Part 3.
- 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. fir, cypress, Pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory 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, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4-inch by 10 feet in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Power and lighting circuits #10 AWG and smaller shall have solid copper conductors. Conductor sizes #8 AWG and larger shall have Class B stranded conductors.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum, or as indicated on the plans.
 1. Bury at least 30 inches below grade.
 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 1. Install bus on insulated spacers 1 inch, 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, down to specified height above floor, and connect to horizontal bus.
- E. 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 Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors' level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and a ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. 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.

- E. 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.
- F. 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.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal 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.

3.4 INSTALLATION

- A. Grounding Conductors: Route along the 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. Common Ground Bonding 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 the 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. Evaluate Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Evaluate Wells: Install at least one test well for each service, unless otherwise indicated. Install it at the ground rod electrically closest to the service entrance. Set top of test well flush with finished grade or floor.

- E. 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 so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service (Domestic and Fire) 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, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, 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.

- G. 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.

- H. 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.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

- B. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less 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.
 - 3. 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. Report measured ground resistances that exceed the following values: Ground resistance shall be evaluated with a ground resistance tester.
 - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 25 ohms.
 - 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 25 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 25 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 25 ohm(s).
 - 5. Substations and Pad-Mounted Equipment: 25 ohms.
 - 6. Manhole Grounds: 25 ohms.

- D. Upon completion of installation of the electrical grounding and bonding systems, the ground resistance shall be evaluated with a ground resistance tester. Where tests show Resistance-to-ground is over 25 ohms, appropriate action should be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods. (The compliance should be demonstrated by retesting.)

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 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. Division 26 Section 260548 "Vibration and 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 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 SUBMITTALS

- A. Product Data: For the following:

1. Steel 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. Equipment supports.
- C. Welding certificates.
- D. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

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 in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. 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.
- D. 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. The body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Power actuated fasteners are not permitted.
- 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:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 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 Division 05 Section "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 inch in 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 single-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. The minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Please add to the specifications that conduits installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of 1/4-inch using "clamp-backs" or strut.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "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 Division 03 Section "Cast-in-Place Concrete (Limited Applications)."
- 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 Division 09 painting Sections 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 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
- C. Raceways shall be metal except as specifically noted, or where non-metallic raceway is permitted by these specifications. A Green Grounding conductor shall be provided in all conduit except for telecommunications, data, and audio conduits.
 - 1. Use heavy wall metal conduit (RMC) or intermediate metal conduit (IMC) for any conduit exposed below a height of 60".
 - 2. Electric metallic tubing (EMT) is permitted for most other general applications except for:
 - a. Where tubing, couplings, elbows and fittings would be in direct contact with the earth or underground (in/below slab-on-grade or in earth).
 - b. Any location outdoors where the tubing, etc., would be exposed to the elements.
 - c. Where exposed to severe corrosive influence and/or physical damage.
- D. Use flexible conduit for appropriate applications. Use galvanized type for dry locations and liquid-tight type for wet locations, or as noted. Flexible conduit shall be minimum 1/2" diameter. Liquid-tight flexible metal conduit shall be used for final connection to all motors, transformers, and other rotating or vibrating equipment. Flexible metal conduit shall be used for final connection to fluorescent lighting fixtures mounted in or on suspended ceilings, and similar applications with a maximum of 6' length. MC cable shall NOT be allowed to be used as a wiring method for branch circuits.
- E. Non-metallic raceway shall be minimum Schedule 40 PVC. In general, non-metallic raceway will be permitted for use underground or in poured concrete (including panel feeders, branch circuits, etc.), provided all 90 degree Ells up out of the floor are heavy wall rigid metal conduit (RMC), no exception. Non-metallic raceways will not be permitted for any exposed work or for raceways in ceiling spaces, etc.
- F. No raceway may be exposed in any finished space unless specifically so approved, in written form, prior to rough-in. Raceways exposed in finished spaces shall be of an appropriate type

"wiremold" type surface raceway or approved equal. In the event of an accepted alternate that requires exposed conditions in a finished space, devices and fixtures shall be located to minimize exposure of raceway and maintain all required clearances, coverage, etc. Devices, fixture, etc. shall be positioned aesthetically/orthogonal to the orientation of the room.

- G. Minimum metal conduit size shall be 3/4" (interior) and 1" (exterior) for premises wiring system. The exception shall be 1/2" for switch legs, control circuits, signal wiring and applications for flexible metal conduits not exceeding four circuit conductors.
- H. Where installing conduit on interior surface of exterior walls, mount conduit minimum 1/4 -inch from wall with clamp-backs or strut.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing, not allowed on this project.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquid tight flexible metal conduit.
- G. LFNC: Liquid tight flexible nonmetallic conduit, not allowed on this project.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic

forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For professional engineer and testing agency.
- E. Source quality-control test reports.
- F. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

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. Comply with NFPA 70.

PART 2 - PRODUCTS -

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AFC Cable Systems, Inc.
 2. Alflex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.5.

- D. PVC-Coated Steel Conduit: PVC-coated IMC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- E. EMT: ANSI C80.3.
- F. FMC: Zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket.
- H. Fittings for Conduit (Including all Types and Flexible and Liquid tight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel, compression type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group.
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; a Hubbell Company.
 - 12. Thomas & Betts Corporation.
- B. ENT: Not allowed.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- D. LFNC: Not allowed.
- E. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 12, unless otherwise indicated.
- C. Fittings and Accessories: Include 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.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized metallic with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.

3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
- J. Cabinets:
1. NEMA 250, Type 1, 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.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: See drawings.
 2. Configuration: Units shall be designed for flush burial and have an open bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, as indicated for each service.

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.

2.8 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.9 SLEEVE SEALS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.

- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION

- A. Underground runs, except under concrete floor slabs, shall have a minimum of 24" cover. Backfill shall be made in 6" layers – tamping each layer to a density of 95% of maximum possible.

- B. Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of 3" of concrete on all sides. Encased raceways shall have a minimum cover of 18", except for raceways containing circuits with voltages above 600 volts, which shall have a minimum cover of 30".

- C. All underground raceways shall be identified by underground line marking tape located directly above the raceway at 6" to 8" below finished grade. Tape shall be permanent, bright colored, continuous printed, metal compounded for direct burial not less than 6" wide and 4 mils thick. Printed legend on tape shall indicate general type of underground line below.

3.2 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit
2. Concealed Conduit, Aboveground: IMC (including elbows that turn up from below grade).
3. Underground Conduit: RNC, Type EPC- 80-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 4.
6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally evaluated according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: IMC.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway.
9. Raceways for Concealed General-Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in 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.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.3 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- 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. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- I. 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.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid, and flexible, as follows:
 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 3. Install a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- M. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
 - 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - 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 the Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 2. 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.
 - 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations not subject to severe physical damage.
- P. 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.
- Q. Set metal floor boxes level and flush with finished floor surface.
- R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.4 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 Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 31 Section "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 Division 31 Section "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
6. All underground raceways shall be identified by underground line marking tape located directly above the raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright-colored, continuous printed, plastic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.

3.5 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut the wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install them in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.9 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
 - 2. Handholes and boxes.
 - 3. Manholes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder details.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- E. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- F. Qualification Data: For professional engineer and testing agency.
- G. Source quality-control test reports.
- H. Field quality-control test reports.
- I. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

- 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 Construction Manager at least two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. ARNCO Corp.
 2. Beck Manufacturing.
 3. Cantex, Inc.
 4. CertainTeed Corp.; Pipe & Plastics Group.
 5. Condux International, Inc.
 6. ElecSys, Inc.
 7. Electri-Flex Company.
 8. IPEX Inc.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT; a division of Cable Design Technologies.
 11. Spiraduct/AFC Cable Systems, Inc.
- B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-80-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- C. Duct Accessories:
 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, "ELECTRIC." Or "TELEPHONE." As indicated for each service.
 7. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
 9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
 1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC." Or "TELEPHONE." As indicated for each service.
 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.
- E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. The cover shall be polymer concrete.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Carson Industries LLC.

- b. Nordic Fiberglass, Inc.
- c. PenCell Plastics.

2.5 MANHOLES AND VAULTS

- A. Underground structures shall be poured in place or of precast construction. The horizontal concrete surface of floors shall have a smooth trowel finish. Concrete shall be cured by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. The curing compound shall conform to ASTM C 309. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Casting shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide all necessary lugs, rabbets, and brackets. Set pull-in irons and other built-in items in place before depositing concrete. The words "electric" and "telephone" shall be cast in the top face of all power and telephone manhole covers, respectively.
- B. Medium Voltage Switch vaults shall have spring assist lids for access to termination and switching compartments.
- C. Optional Precast Concrete Construction: In lieu of poured-in-place concrete manholes and hand holds, the Contractor may, at his option, provide precast concrete structures subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes and handholds.
- D. General: Precast concrete structures shall have the same accessories and facilities as required for poured-in-place structures. Likewise, they shall have planned area and clear heights not less than those of poured-in-place structures. Concrete materials and methods of construction shall be the same as for poured-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have an ultimate 28-day compressive strength of not less than 4000 pounds per square inch. Structures may be precast to the design and details shown for poured-in-place construction, precast monolithically and placed as a unit; or, they may be of assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. All structures shall be identified with the manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.
- E. Structure top and bottom shall be designed for full dead, superimposed dead and live load including impact. Structure sidewalls shall be designed for lateral earth and hydrostatic pressures plus live load (H20 Truck) adjacent to structure. Tops and walls of structures shall be designed for AASHTO standard H20 highway loading, with 30 percent loading added for impact and with design load being that which produces maximum shear and moment. All dead and live loads, as well as impact loading, shall be considered in design. Walls shall be designed to withstand all soil pressures, taking into consideration the soil to be encountered and ground water level present at the site and assuming that the H20 design vehicle will operate on surfaces adjacent to the structure. The ground water level shall be assumed to be three feet below ground surface unless a higher water table is indicated in the boring logs. Design shall also take into consideration stresses induced in handling units. Lifting devices shall be provided for properly

handling units. Calculations and shop drawings shall be submitted covering the design and manufacture of precast units and shall bear the seal of registered professional engineer.

- F. Joints: Mating edges of precast components shall be provided with tongue and grooved joints. Joints shall be designed to firmly interlock adjoining components and to provide waterproof junctions. Joints shall be sealed watertight using preformed plastic strip conforming to AASHTO M 198, Type B. Sealing material shall be installed in strict accordance with the sealant manufacturer's printed instructions. Provisions shall be made for waterproofing cable entrances into structures and at covers in the top slab.
- G. Pulling-in irons shall be steel bars bent as indicated on drawings and cast in the walls and floors. In the floor they shall be centered under the cover, and in the wall, they shall be not less than 6 inches above or below, and opposite the conduits entering the structure. Pulling-in irons shall be projected into the structure approximately 4 inches. Irons shall be zinc-coated after fabrication.
- H. Cable racks, including arms, shall be made from 50% glass-reinforced nylon or a non-metallic material having equal mechanical strength, thermal resistance, chemical resistance, and dielectric physical properties. Cable racks, including rack arms and insulators, shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 3 feet apart and each manhole wall shall be provided with a minimum of 2 racks.
 - 1. Provide stainless steel hardware for mounting fasteners. Coat threads of anchor bolts with anti-seize compound immediately prior to installing nuts.
 - 2. Rack arms shall be 8", removable type, and rated capable of supporting 450 lbs. working load and 1,000 lbs. short term rated.
 - 3. Rack arms shall have slots or holes for securing cables with non-metallic cable wire ties.
- I. Precast Manhole/Vault Installation: Commercial precast assembly shall be set on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to one inch size extending 12 inches beyond the manhole on each side. Granular fill shall be compacted by a minimum of four passes with a plate type vibrator. Drain sumps shall be provided for all precast structures.
- J. Coordinate requirement for sump pumps in manholes and vaults with Project Manager.
- K. Install 1/0 bars copper ground conduct around inside perimeter of manhole. Connect to 3/4" x 10' - 0" ground rod inside manhole. Bond with #6 bare copper from ring to manhole cover frame, sump covers, etc. PRECAST MANHOLES
- L. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast Group.
 - 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile, Inc.
- M. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- N. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- O. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."
- C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.7 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bilco Company (The).
 2. Campbell Foundry Company.
 3. Carder Concrete Products.
 4. Christy Concrete Products.
 5. East Jordan Iron Works, Inc.
 6. Elmhurst-Chicago Stone Co.
 7. McKinley Iron Works, Inc.
 8. Neenah Foundry Company.
 9. NewBasis.
 10. Oldcastle Precast Group.
 11. Osburn Associates, Inc.
 12. Pennsylvania Insert Corporation.
 13. Riverton Concrete Products; a division of Cretex Companies, Inc.
 14. Strongwell Corporation; Lenoir City Division.
 15. Underground Devices, Inc.

16. Utility Concrete Products, LLC.
 17. Utility Vault Co.
 18. Wausau Tile, Inc.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.
- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 1. Evaluated Ultimate Pullout Strength: 12,000 lbf minimum.
- H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

- J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - 1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
 - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. The top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- L. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- M. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches. One required.
- N. Cover Hooks: Heavy duty, designed for lifts of 60 lb. and greater. Two required.

2.8 SOURCE QUALITY CONTROL

- A. Evaluate and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

2.9 SOURCE QUALITY CONTROL

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 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- F. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.
- G. Concrete encased medium voltage duct banks shall be colored red.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally evaluated according to SCTE 77 with 3000-lbf vertical loading.
- B. Manholes: Precast or cast-in-place concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Division 22 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for minor changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches 12.5 feet 25 feet, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical/Common Work Results for Communications/Common Work Results for Electronic Safety and Security."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie the entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion

- fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
- b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. **Pouring Concrete:** Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to the center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 4. **Reinforcement:** Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 5. **Forms:** Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 6. **Minimum Space between Ducts:** 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 7. **Depth:** Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
 8. **Stub-Ups:** Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
 9. **Stub-Ups:** Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. **Stub-Ups to Equipment:** For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 10. **Underground Identification:** All underground piping and utilities (both metallic and non-metallic), except copper pipe, shall have a separate copper tracer wire and non-metallic warning tape installed above the utility line.
 - A. The tracer wire shall be traced for continuity prior to backfill, immediately upon completion of backfill and compaction and once again during final utility location/as-built at the end of the project. This also will include landscape irrigation mains to the points of the valves. All above ground utility features such as vaults, manholes, valves, handholds, etc. to be properly labeled. The contractor shall provide an inventory of all installed outdoor utility features including type and model.
 - B. **IDENTIFICATION TAPE:** The 1st stage of identification shall be a buried warning tape. This tape shall provide an early warning at shallow depth excavation. The tape shall be 6" wide and buried approximately 18" to 30" above the service pipe, but a minimum of 10" below finished grade. It shall consist of multiple layers of polyethylene with an overall thickness of 3 to 5 mils. It shall be installed continuous from valve box to valve box or manhole to manhole and shall terminate just outside of valve box or manhole wall. The black colored lettering on the warning tape shall be abrasion resistant and be imprinted on a color-coded background that conforms to APWA color code standards. The lettering on the tape should name the utility it is protecting (i.e., Caution buried sewer line below).
 - C. **TRACER WIRE:** The 2nd stage of identification shall be a buried tracer wire. This tracer wire shall provide pipeline identification, be fully detectable from above grade utility locators, and be able to provide a depth reference point to top of pipe.

D. All pipe, including lawn irrigation lines, and metallic pipe with compression gasket fittings installed underground shall have a tracer wire installed along the length of the pipe. The wire shall be taped to the top of the pipe at a maximum of 10' intervals and not allowed to "float freely" within the backfill.

E. Tracer wire shall be single-conductor, 12 gauge minimum, copper single-conductor wire with type "UF" (Underground Feeder) insulation and shall be continuous along the pipeline passing through the inside of each valve box. A #12 AWG or heavier (smaller AWG number), solid, insulated (RHW, THW, or polyethylene insulation is recommended); copper wire shall be taped to pipe at 10-foot intervals. Do not wrap wire around pipe. The wire must be one continuous, unbroken length. Coil tracer wire at meter location and street end with enough wire to extend a minimum of two feet above grade.

11. Concrete encased medium voltage duct banks shall be colored red.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 22 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 22 Section "Earth Moving."
5. After installing the first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing the last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 22 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. Underground Identification: All underground piping and utilities (both metallic and non-metallic), except copper pipe, shall have a separate copper tracer wire and non-metallic warning tape installed above the utility line.
 - A. The tracer wire shall be traced for continuity prior to backfill, immediately upon completion of backfill and compaction and once again during final utility location/as-built at the end of the project. This also will include landscape irrigation mains to the

points of the valves. All above ground utility features such as vaults, manholes, valves, handholds, etc. to be properly labeled. The contractor shall provide an inventory of all installed outdoor utility features including type and model.

B. IDENTIFICATION TAPE: The 1st stage of identification shall be a buried warning tape. This tape shall provide an early warning at shallow depth excavation. The tape shall be 6" wide and buried approximately 18" to 30" above the service pipe, but a minimum of 10" below finished grade. It shall consist of multiple layers of polyethylene with an overall thickness of 3 to 5 mils. It shall be installed continuous from valve box to valve box or manhole to manhole and shall terminate just outside of valve box or manhole wall. The black colored lettering on the warning tape shall be abrasion resistant and be imprinted on a color-coded background that conforms to APWA color code standards. The lettering on the tape should name the utility it is protecting (i.e., Caution buried sewer line below).

C. TRACER WIRE: The 2nd stage of identification shall be a buried tracer wire. This tracer wire shall provide pipeline identification, be fully detectable from above grade utility locators, and be able to provide a depth reference point to top of pipe.

D. All pipe, including lawn irrigation lines, and metallic pipe with compression gasket fittings installed underground shall have a tracer wire installed along the length of the pipe. The wire shall be taped to the top of the pipe at a maximum of 10' intervals and not allowed to "float freely" within the backfill.

E. Tracer wire shall be single-conductor, 12 gauge minimum, copper single-conductor wire with type "UF" (Underground Feeder) insulation and shall be continuous along the pipeline passing through the inside of each valve box. A #12 AWG or heavier (smaller AWG number), solid, insulated (RHW, THW, or polyethylene insulation is recommended); copper wire shall be taped to pipe at 10-foot intervals. Do not wrap wire around pipe. The wire must be one continuous, unbroken length. Coil tracer wire at meter location and street end with enough wire to extend a minimum of two feet above grade.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units' level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line, 12" below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Thermoplastic Sheet Waterproofing." "After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Damp proofing: Apply damp proofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Damp proofing materials and installation are specified in Division 07 Section "Bituminous Damp proofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- K. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and traffic ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line, 12" below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to

be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut the wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. The bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. After the duct line has been completed, a mandrel not less than 12 inches long, having across section approximately one-fourth inch less than the inside cross section of the conduit shall be pulled through each conduit after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth, sand, or gravel have been left in the lines.
 - 3.
 - 4. Evaluate manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Spring isolators.
 - 3. Restrained spring isolators.
 - 4. Channel support systems.
 - 5. Restraint cables.
 - 6. Hanger rod stiffeners.
 - 7. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I
 - a. Component Importance Factor: 1.25
 - b. Component Response Modification Factor:
 - c. Component Amplification Factor:
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
 - 4. Design Spectral Response Acceleration at 1.0-Second Period:

1.5 SUBMITTALS

- A. Product Data: For the following:
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 seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer, **Licensed in North Carolina**, responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 3. Field-fabricated supports.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates.
- E. Qualification Data: For professional engineer and testing agency.
- F. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.6 QUALITY ASSURANCE

- A. 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 third-party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.” See link for approved testing laboratories: <https://www.ncosfm.gov/codes/state-electrical-division/qualified-testing-laboratories>.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control.
 - 6. Mason Industries.
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation.
 - 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment. Not permitted for generator installation.
 - 1. Resilient Material: Oil- and water-resistant neoprene rubber hermetically sealed compressed fiberglass.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
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.

2.2 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES OSHPD, an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- D. Restraint Cables: ASTM A 603 galvanized -steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as evaluated according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as evaluated according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- 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 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify the position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Evaluate at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Evaluate 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. If a device fails a test, modify all installations of the same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48

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 Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- D. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, 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 acoustic ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.
- B. All outlet boxes, junction boxes and pull boxes shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme outlined below (2.6A). This includes covers on boxes above lift-out and other type accessible ceilings.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.4 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. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. 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."
 3. Provide "ARC FLASH" warning labels on all switchboards, power panels, enclosed circuit breakers, ATS and other equipment where this hazard exists, as per NEC 110.16

2.5 INSTRUCTION SIGNS

- A. Engraved laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment to applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Furnish and install engraved laminated phenolic nameplates for all safety switches, panelboards, and other electrical equipment supplied for the project for identification. Nameplates shall be securely attached to equipment with self-tapping stainless-steel screws; if the screw sharp end is protected; otherwise, rivets shall be used. Two-part epoxy is also acceptable. Letters shall be approximately 1/2-inch-high minimum. Embossed, self-adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:
 - Blue surface with white core for 120/208-volt equipment
 - Black surface with white core for 277/480-volt equipment
 - Bright red surface with white core for all equipment related to fire alarm system.
 - Dark red (burgundy) surface with white core for all equipment related to security.
 - Green surface with white core for all equipment related to "emergency" systems.
 - Orange surface with white core for all equipment related to telephone systems.

- Brown surface with white core for all equipment related to data systems.
- White surface with black core for all equipment related to paging systems.
- Purple surface with white core for all equipment related to TV systems.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):

a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

- 1) Primer: Exterior concrete and masonry primer.
- 2) Finish Coats: Exterior semigloss acrylic enamel.

2. Exterior Concrete Unit Masonry:

a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

- 1) Block Filler: Concrete unit masonry block filler.
- 2) Finish Coats: Exterior semigloss acrylic enamel.

3. Exterior Ferrous Metal:

a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

- 1) Primer: Exterior ferrous-metal primer.
- 2) Finish Coats: Exterior semigloss alkyd enamel.

4. Exterior Zinc-Coated Metal (except Raceways):

a. Semigloss Alkyd-Enamel Finish: One finish coat(s) over a primer.

- 1) Primer: Exterior zinc-coated metal primer.
- 2) Finish Coats: Exterior semigloss alkyd enamel.

5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):

a. Semigloss Alkyd-Enamel Finish: One finish coat(s) over a primer.

- 1) Primer: Interior concrete and masonry primer.
- 2) Finish Coats: Interior semigloss alkyd enamel.

6. Interior Concrete Unit Masonry:

- a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- 7. Interior Gypsum Board:
 - a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Interior gypsum board primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- 8. Interior Ferrous Metal:
 - a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- 9. Interior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws

PART 3 - EXECUTION

3.1 APPLICATION

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 100A: Identify with orange self-adhesive vinyl label.

- D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands: Unless there is standard campus-wide color code, use the following Nameplate material colors shall be as follows:

Blue surface with white core for 120/208-volt equipment.
Black surface with white core for 277/480-volt equipment.
Bright red surface with white core for all equipment related to fire alarm system.
Dark red (burgundy) surface with white core for all equipment related to security.
Green surface with white core for all equipment related to "emergency" systems.
Orange surface with white core for all equipment related to telephone systems.
Brown surface with white core for all equipment related to data systems.
White surface with black core for all equipment related to paging systems.
Purple surface with white core for all equipment related to TV systems.

- E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
- G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data 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 Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. 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.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door, or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Instruction Signs:

1. Operating Instructions: 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.
2. Emergency Operating Instructions: 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 or load shedding.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and 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: In Accordance with paragraph 3.1.D:

- 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 2 lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. In outdoor locations, labels shall be applied using two-part epoxy that is weatherproof and sunlight resistant.
- c. Elevated Components: Increase the sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.
- c. Electrical switchgear and switchboards.
- d. Transformers.
- e. Electrical substations.
- f. Emergency system boxes and enclosures.
- g. Motor-control centers.
- h. Disconnect switches.
- i. Enclosed circuit breakers.
- j. Motor starters.
- k. Push-button stations.
- l. Power transfer equipment.
- m. Contactors.
- n. Remote-controlled switches, dimmer modules, and control devices.
- o. Battery inverter units.
- p. Battery racks.
- q. Power-generating units.
- r. Voice and data cable terminal equipment.
- s. Master clock and program equipment.
- t. Intercommunication and call system master and staff stations.
- u. Television/audio components, racks, and controls.
- v. Fire-alarm control panel and annunciators.
- w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.

- x. Monitoring and control equipment.
 - y. Uninterruptible power supply equipment.
 - z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
- M. Emergency light fixtures – Interior
- 1. Provide a red sticker with white lettering “E.” Sticker size to be ½.” Sticker shall be attached to frame of the emergency light fixture, and where frame is not ½” or larger, attach to local ceiling grid, or gypsum ceiling next to fixture.

3.2 INSTALLATION

- A. Verify the 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 non adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color 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. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 - e. Ground: Green
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Grey
 - e. Ground: Green
 - 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made.

Apply the last two turns of tape with no tension to prevent unwinding. Locate bands to avoid obscuring factory cable markings.

- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. 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.
- J. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION 26 05 53

SECTION 26 08 00 – ELECTRICAL SYSTEMS COMMISSIONING

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.
- B. Section C408 of the 2018 North Carolina Energy Conservation Code (NCECC).

1.2 SUMMARY

- A. This section includes commissioning process requirements for lighting control systems per Section C408 of the 2018 North Carolina Energy Conservation Code (NCECC). and the backup power system.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

- A. Refer to Division 01 Section "General Commissioning Requirements" for the description of commissioning.

1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

1.5 SUBMITTALS

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.
- B. Refer to Division 01 Section "Submittals" for specific requirements. In addition, provide the following:
- C. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Test reports.

1.6 QUALITY ASSURANCE

- A. Evaluate Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to evaluate instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Special equipment, tools, and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. The manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to evaluate equipment will be provided by the CxA but shall not become the property of the Owner.
- E. All testing equipment shall be of sufficient quality and accuracy to evaluate and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.
- B. Red-lined Drawings:

1. The contractor will verify all equipment, systems, instrumentation, wiring, and components are shown correctly on red-lined drawings.
 2. Preliminary, red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
 4. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data:
1. The contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
 2. The CxA will review the O&M literature once for conformance to project requirements.
 3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Systems manual requirements:
1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 2. The GC shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Schematics
 - b. Verified Record Drawings
 - c. Evaluate Results (not otherwise included in Cx Record)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information.
 - g. Training Records, Information on training provided, attendees list, and any on-going training.
 3. This information shall be organized and arranged logically.
 4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.
- 3.2 CONTRACTOR'S RESPONSIBILITIES
- A. Perform commissioning tests at the direction of the CxA.
 - B. Attending construction phase controls coordination meetings.
 - C. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
 - D. Provide information requested by the CxA for final commissioning documentation.

- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. During the startup and initial checkout process, execute the related portions of the Prefunctional Checklists for all commissioned equipment.
- I. Assist the CxA in all verification and functional performance tests.
- J. 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.
- K. Gather operation and maintenance literature on all equipment and assemble it in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- L. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- M. Notify the CxA a minimum of two weeks in advance of the time for the start of the testing and balancing work. Attend the initial testing and balancing meetings for review of the official testing and balancing procedures.
- N. Participate in, and schedule vendors and contractors to participate in the training sessions.
- O. Provide written notification to the CM/GC and CxA that the lighting control system work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
- P. The equipment supplier shall document the performance of his equipment.
- Q. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
- R. Provide training for the Owner's operating staff using expert qualified personnel, as specified.
- S. Equipment Suppliers
 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 2. Assist in equipment testing per agreements with contractors.
 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
- T. Refer to Division 01 Section "General Commissioning Requirements" for additional Contractor responsibilities.

3.3 OWNER'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Owner's Responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Design Professional's Responsibilities.

3.5 CxA'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.

3.6 TESTING PREPARATION

- A. Certify in writing to the CxA that the lighting control system has been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that Electrical 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 in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be evaluated (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.

3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Evaluate 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 may direct that set points be altered when simulating conditions is not practical.
- E. 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.
- F. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.8 LIGHTING CONTROL SYSTEM TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections.
- B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:
 - 1. Lighting control system and components including occupancy sensors, vacancy sensors, time clocks, and daylight responsive controls.
 - 2. Coordination and functionality with the Building Automation System/Building Management Controls System
 - 3. Battery Monitoring System

3.9 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.10 APPROVAL

- A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.11 DEFERRED TESTING

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.12 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review, and approval process.

3.13 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.
- B. Electrical Contractor. The electrical contractor shall have the following training responsibilities:
 - 1. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
 - 2. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
 - 3. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary, and the demonstration repeated.
 - 4. The appropriate trade or manufacturer's representative shall provide instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
 - 5. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 - 6. Training shall include:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discuss relevant health and safety issues and concerns.
 - d. Discuss warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discuss any peculiarities of equipment installation or operation.
 - 7. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance of all pieces of equipment.
 - 8. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
 - 9. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's.

END OF SECTION 26 08 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor and indoor photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Outdoor motion sensors.
 - 5. Lighting contactors.
 - 6. Emergency shunt relays.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- E. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

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.

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Area Lighting Research, Inc.; Tyco Electronics.
 - 2. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 3. Intermatic, Inc.
 - 4. Leviton Mfg. Company Inc.
 - 5. Lightolier Controls; a Genlyte Company.
 - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 7. Paragon Electric Co.; Invensys Climate Controls.
 - 8. Square D; Schneider Electric.
 - 9. TORK.
 - 10. Touch-Plate, Inc.
 - 11. Watt Stopper (The).
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
 - 1. Contact Configuration: DPST.
 - 2. Contact Rating: 20-A ballast load, 120/240-V ac.
 - 3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
 - 4. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 - 5. Programs: 4 channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
 - 6. Programs: 2 channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule with skip-a-day weekly schedule.
 - 7. Programs: 2 channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 - 8. Programs: 2 channels; each channel shall be individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.

9. Programs: 2 channels; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
10. Program: 2 and an annual holiday schedule that overrides the weekly operation on holidays.
11. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
12. Astronomic Time: selected channels.
13. Battery Backup: For schedules and time clock.

C. Electromechanical-Dial Time Switches: Type complying with UL 917.

1. Contact Configuration: DPST.
2. Contact Rating: 20-A ballast load, 120/240-V ac.
3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
4. Astronomic time dial.
5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
6. Skip-a-day mode.
7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Novitas, Inc.
6. Paragon Electric Co.; Invensys Climate Controls.
7. Square D; Schneider Electric.
8. TORK.
9. Touch-Plate, Inc.
10. Watt Stopper (The).

B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 30-second minimum, to prevent false operation.
3. Lightning Arrester: Air-gap type.
4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 INDOOR PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. Area Lighting Research, Inc.; Tyco Electronics.
 3. Eaton Electrical Inc; Cutler-Hammer Products.
 4. Grasslin Controls Corporation; a GE Industrial Systems Company.
 5. Intermatic, Inc.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. MicroLite Lighting Control Systems.
 8. Novitas, Inc.
 9. Paragon Electric Co.; Invensys Climate Controls.
 10. Square D; Schneider Electric.
 11. TORK.
 12. Touch-Plate, Inc.
 13. Watt Stopper (The).
- B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.
- C. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit mounted on luminaire, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 3. Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.

5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 INDOOR OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Hubbell Lighting.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Novitas, Inc.
 5. RAB Lighting, Inc.
 6. Sensor Switch, Inc.
 7. TORK.
 8. Watt Stopper (The).
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time, delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
 1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.5 LIGHTING CONTACTORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 4. GE Industrial Systems; Total Lighting Control.
 5. Grasslin Controls Corporation; a GE Industrial Systems Company.
 6. Hubbell Lighting.
 7. Lithonia Lighting; Acuity Lighting Group, Inc.
 8. MicroLite Lighting Control Systems.
 9. Square D; Schneider Electric.
 10. TORK.
 11. Touch-Plate, Inc.
 12. Watt Stopper (The).
- B. Description: Electrically operated and mechanically held, combination type with non-fused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.6 EMERGENCY SHUNT RELAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Lighting Control and Design, Inc.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
 - 1. Coil Rating: 120 V.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to the Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- 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.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For testing agency.
- E. Source quality-control test reports.
- F. Field quality-control test reports.

- G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
- H. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.4 QUALITY ASSURANCE

- A. 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.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- 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.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
- F. Efficiency – Per DOE 10 CFR 431.192.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.7 SUPPORT SYSTEMS

- A. The following minimum mounting and installation guidelines shall be followed for transformer support, unless specifically modified by the above referenced standards.
- a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared, and stamped by a licensed engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment meets or exceeds the specified response spectra.
 - b. Provide a letter of conformance for the support frame, signed, and sealed by a Professional Engineer registered in the Project State.
 - c. Pre-engineered structures such as “GEARSTACKER” products, (www.gearstacker.com), will be acceptable provided the submittal contains complete documentation for the specific support application.
 - d. The E.C. is to coordinate any additional required wall bracing with G.C. prior to work beginning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Products.
 2. General Electric Company.
 3. Siemens Energy & Automation, Inc.
 4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -evaluated, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.
- D. CSA 802.2-00 Minimum Efficiency Values for Dry Type Transformers

Energy Conservation Standards for Low-Voltage Dry-Type Distribution Transformers			
Single phase		Three phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	97.7	15	97.0
25	98.0	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98.0
75	98.5	112.5	98.2
100	98.6	150	98.3
167	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
		750	98.8
		1000	98.9

Note: All efficiency values are at 35 percent of nameplate-rated load.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: Ventilated, NEMA 250, Type 3R.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: ANSI 49 gray.
- G. Taps for Transformers 7.5 to 24 kVA: Manufacturer's Standard
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

- J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with EPA Act 2005, efficiency levels.
 - 2. Evaluated according to NEMA TP 2.
- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
 - 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Sound-Level Requirements: NEMA ST 20 standard sound levels when factory evaluated according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution or buck-boost transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Evaluate and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at the location of transformer.

- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Remove and replace units that do not pass tests or inspections and retest as specified above.
- C. Evaluate Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to evaluated component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

LOW-VOLTAGE TRANSFORMERS

SECTION 26 22 00

END OF SECTION 26 22 00

SECTION 26 24 13 - SWITCHBOARDS

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.
- B. E.C. responsible for all Breaker Testing required.
- C. Gear manufacturer shall provide a full coordination study to the Engineer for approval during the submittal process. The Coordination Study is to be sealed by an engineer licensed in North Carolina.
- D. A. Switchboard shall be provided with painted "schematic" bus on front of enclosure to depict actual bus arrangement inside cubicles.
- E. Provide a laminated drawing of the building electrical riser next to each switchboard in the main electrical room framed and mounted under glass.
- F. Primary current injection testing of the GFPE equipment is required and a written record of the test should be included in final project documents per NEC 230.95 (C).
- G. Arc Energy Reduction documentation shall be provided to the electrical inspector to demonstrate the method chosen to reduce clearing time is set to operate at a value below the available arcing current per NEC 240.87.

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V or less.
 - 2. Transient voltage suppression devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Control power.
 - 6. Accessory components and features.
 - 7. Identification.
 - 8. Mimic bus.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

- A. **Product Data:** For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. **Shop Drawings:** For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 8. Include diagram and details of proposed mimic bus.
 - 9. Include schematic and wiring diagrams for power, signal, and control wiring.
 - 10. The engineer of record must seal and sign the manufacturers' Short-Circuit Analysis.
- C. **Samples:** Representative portion of mimic bus with specified material and finish, for color selection.
- D. **Qualification Data:** For qualified Installer.
- E. **Seismic Qualification Certificates:** Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. **Field Quality-Control Reports:**
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- G. **Operation and Maintenance Data:** For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
- H. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. 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 third-party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment." See link for approved testing laboratories: <https://www.ncosfm.gov/codes/state-electrical-division/qualified-testing-laboratories>.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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 PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Manage and prepare switchboards for installation according to NEMA PB 2.1.
- D. Storage: stored equipment must be either on-site, or in a bonded warehouse accessible for inspection by the State Construction office and located within the state of North Carolina.

1.7 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide a pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards 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 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- D. 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 at least seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Architect's written permission.
 - 4. Comply with NFPA 70E.

1.8 COORDINATION

- A. Coordinate layout and installation of switchboards 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 in Division 03.

1.9 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 of work.

1.10 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but at least two of each size and type.
 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but at least two of each size and type.
 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but at least three of each size and type.
 4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but at least three of each size and type.
 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but at least three of each size and type.
 6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but at least one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. GE/ABB.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Drawout, individually mounted.
 2. Branch Devices: Fixed, panel mounted.
 3. Sections front and rear aligned.
- C. Nominal System Voltage: as indicated on the drawings.
- D. Main-Bus Continuous: silver plated copper of the ampacity as indicated on the drawings.
- E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. Indoor Enclosures: Steel, NEMA 250, Type 1.
- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- H. Barriers: Between adjacent switchboard sections.
- I. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

- J. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
- K. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- L. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- M. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.
- N. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- O. Pull Box on Top of Switchboard:
1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 2. Set back from front to clear circuit-breaker removal mechanism.
 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 4. The bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- P. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Phase- and Neutral-Bus Material: silver plated hard-drawn copper of 98 percent conductivity, copper feeder circuit-breaker line connections.
 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 3. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- Q. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

- R. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, fully rated to interrupt the short-circuit current available at terminals. Series ratings are not allowed.
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. Breakers 1200A and above shall be drawout type. Breakers smaller than 1200A shall be fixed.
 3. All circuit breakers rated 1200A or higher, capable of being rated 1200A or higher (I.e., adjustable long-time pickup or replaceable trip/rating plug), shall be provided with an energy-reducing maintenance switch with local status indicator. Arc incident energy reduction shall be in compliance with NEC 240.87.
 4. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 5. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 6. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 7. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 8. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 9. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 10. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."

- g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contact's mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.3 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 - 1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, tapped secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated: All values to be in true RMS.
 - a. Phase Currents, Each Phase: Plus, or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus, or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus, or minus 1 percent.
 - d. Megawatts: Plus, or minus 2 percent.
 - e. Megavars: Plus, or minus 2 percent.
 - f. Power Factor: Plus, or minus 2 percent.
 - g. Frequency: Plus, or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus, or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus, or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Phase current Demand.
 - k. VA Demand.
 - l. VAR demand
 - m. Contact devices to operate remote impulse-totalizing demand meter.
 - n. 4 output relays and 4 isolated analog outputs that can replace transducers.
 - o. The Power Meter shall have built-in data communications to allow multi-point communication to multiple computer workstations, programmable controllers, and other host devices, at a minimum data rate of 9600 baud. The Power Meter shall be able to communicate with the Owners Tridium Niagara Software through the Network Area Controller, NAC, Panel for building management and/or other monitoring functions. The Power Meter shall be compatible with Modbus RTU Communications.
 - p. The Power Meter shall be able to perform Harmonic Analysis with trigger trace memory, waveform capture, event recorder and data logger.

2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

2.4 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Provide a lifting carriage for the
- C. Not Used.

2.6 IDENTIFICATION

- A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.
 1. Nameplate: At least 0.032-inch- thick anodized aluminum, located at eye level on the front cover of the switchboard incoming service section.
- B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.
- C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
- E. Upon completion of installation, and prior to final inspection, the contractor shall reduce in size the "as-built" single line diagram (riser), frame diagram under glass, and mount in a conspicuous place adjacent to the switchboard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards 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 switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."
 - 1. 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.
 - 2. For supported equipment, 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 switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Install spare-fuse cabinet.
- I. Comply with NECA 1.

3.3 CONNECTIONS

- A. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.
- B. Support and secure conductors within switchboard in accordance with NFPA 70.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Switchboards identified for use as service equipment shall be so labeled.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections as required by the equipment manufacturer to ensure all warranties are valid.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, evaluate, and adjust components, assemblies, and equipment installations, including connections.
- C. 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.
- D. Acceptance Testing Preparation:
 - 1. Evaluate insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Not used.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Final Acceptance.
 - 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.
 4. Evaluate and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 5. The following tests shall be performed on the service circuit breakers and the distribution circuit breakers. Testing shall be performed by a qualified factory technician at the job site. All readings shall be tabulated:
 - a. Phase tripping tolerance (within 20% of U/L requirements)
 - b. Trip time (per phase) in seconds.
 - c. Instantaneous trip (amps) per phase.
 - d. Insulation resistance (in megohms) at 100 volts (phase to phase, and line to load).
 6. The ground fault protection on the new circuit breakers (if provided) shall be performance evaluated in the field and properly calibrated and set in accordance with the coordination study.
- F. The switchboard will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. All tests shall be completely documented indicating time of day, date, temperature, and all pertinent test information. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for final acceptance of the project.
- 3.6 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
 - B. Set field-adjustable circuit-breaker trip ranges as indicated.
- 3.7 PROTECTION
- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

3.9 SHORT CIRCUIT STUDY:

- a. A complete short circuit and protection coordination study with coordination plots for each medium and low voltage distribution system shall be provided. The studies shall include the power company's system and relay characteristics, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, impedance diagrams, conclusions, and recommendations. A ground fault study shall be provided for the low voltage system, which shall include the associated zero sequence impedance diagrams. Short circuit momentary duties, when applicable, and interrupting duties shall be calculated on the basis of an assumed fault at each medium voltage switchgear line-up, low voltage switchgear line-up, switchboard, distribution panelboard, pertinent branch circuit panelboard, generator, and other significant locations throughout the systems. The short circuit tabulations shall include the fault impedances, X to R ratios, asymmetry factors, KVA symmetrical and asymmetrical fault currents. This study is to be prepared and sealed by a professional engineer licensed in North Carolina.
- b. The coordination plots required shall graphically indicate the coordination proposed for the several systems centered on full scale log forms. The coordination plots shall include complete titles, representative one-line diagrams and legends, associated power company's relay or system characteristics, medium voltage fuses and relays, significant equipment starting characteristics, complete parameters for transformers, complete operating bands for low voltage switchgear or switchboard circuit breaker trip devices, and the associated system load protective devices. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time dial settings and pick up settings required. The long-time region of the coordination plots shall indicate a complete tap scale for each medium voltage relay, full load current and 150, 400 or 600 percent full load current transformer parameters and designate the pick-ups required for the low voltage circuit breakers. The brief time region shall indicate the medium voltage relay instantaneous elements, the magnetizing inrush, ANSI withstand thermal and mechanical transformer parameters, fuse manufacturing tolerance bands, and significant symmetrical and asymmetrical fault currents. Each primary protective device required for a delta-grounded wye connected transformer shall be selected so the characteristic or operating band is within the transformer parameters and shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line to ground faults. The transformer damage curve shall be included for each transformer. Low voltage power circuit breakers shall provide long time, long time delay, short time, short time delay, ground fault, ground fault delay, and I^2t in/out settings with coordination plots and shall be separated from each other and the associated primary protective device by a 16 percent current margin for coordination and protection in the event of secondary line to line or line to ground fault. Medium voltage relays shall be separated by a 0.4 second time margin when the maximum three phase fault flows, to assure proper selectivity. The protective device characteristics or operating band shall reflect the actual symmetrical and asymmetrical fault currents sensed by the device.
- c. The contractor shall note that the drawings and specifications indicate the general requirements for the equipment, the medium voltage and low voltage equipment, but addi

tional specific characteristics of equipment furnished shall be determined in accordance with the results of the short circuit and protection coordination study. The equipment design discrepancies and the proposed corrective modifications, if required, shall be submitted with the short circuit and protection coordination study with any variations clearly noted on the subsequent shop drawings. Necessary field settings, adjustments, and minor modifications for conformance with the approved short circuit and protection coordination study shall be accomplished by the particular manufacturer or by the Contractor without additional expense to the Owner. However, should equipment specified be outside the parameters required by this study, a change order to modify the equipment shall be issued if the engineer's review warrants such a change. Equipment shop drawings shall not be submitted until the short circuit and protection coordination study has been reviewed by the Owner's engineer.

- d. Arc-Flash labels shall be printed per OSHA requirements and shall be installed by the contractor.

PART 3: EXECUTION

POINT SETTINGS:

- a. The Electrical Contractor shall set and calibrate all target points and settings indicated on the approved coordination study prior to energizing and evaluating the system.
- b. The study shall require the Electrical Contractor to provide the following information:
 - 1. Length, type, resistance, reactance of all cables both medium and low voltages.
 - 2. Fuse curves as required.
 - 3. Utility information.

END OF SECTION 26 24 13

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.
- B. E.C. responsible for all On-Site Breaker Testing required.
- C. Gear manufacturer shall provide a full coordination study to the Engineer for approval during the submittal process.
- D. E.C. is to label service equipment with maximum available fault current per NEC Art 110.24A

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective 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. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Series Rated Breakers are not permitted.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

- f. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
2. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - D. Qualification Data: For testing agency.
 - E. Field quality-control test reports including the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - F. Panelboard Schedules: For installation on panelboards.
 - G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "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.
 - H. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 QUALITY ASSURANCE

- A. 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.) Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment." See link for approved testing laboratories: <https://www.ncosfm.gov/codes/state-electrical-division/qualified-testing-laboratories>.
 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.

- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- 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.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F.
 - 2. 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.

1.7 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, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Three spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. GE/ABB.

- c. Siemens Energy & Automation, Inc.
- d. Square D.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
 - 7. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 - 8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- C. Phase, neutral, bolt-on circuit breakers, and Ground Buses:
 - 1. Material: Copper.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
 - 3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
 - 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 - 5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material.
 - 1. Main and Neutral Lugs: Compression type.
 - 2. Ground Lugs and Bus Configured Terminators: Compression type.
 - 3. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- G. The maximum number of breakers in a panelboard shall not exceed 42 poles.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- B. Series rated equipment is not allowed.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breaker, see plans.
- C. Branch Overcurrent Protective Devices:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- D. All circuit breakers rated 1200A or higher, capable of being rated 1200A or higher (I.e., adjustable long-time pickup or replaceable trip/rating plug), shall be provided with an energy-reducing maintenance switch with local status indicator. Arc incident energy reduction shall be in compliance with NEC 240.87.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with full rating 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 100 A and larger. A push-to trip button shall be provided on the cover for mechanically tripping the breaker. The breaker shall have reverse connection capability and be suitable for mounting and operating in any position.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with 5 or 30-mA trip sensitivity. See plans.

- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 4. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contact's mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 10. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.
 11. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

2.7 CONTROLLERS

- A. Motor Controllers: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:
1. Individual control-power transformers.
 2. Fuses for control-power transformers.
 3. Bimetallic-element overload relay.
 4. Indicating lights.
 5. Seal-in contact.
 6. 2 convertible auxiliary contacts.
 7. Push buttons.
 8. Selector switches.
- B. Contactors: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:
1. Individual control-power transformers.
 2. Fuses for control-power transformers.
 3. Indicating lights.
 4. Seal-in contact.
 5. 2 convertible auxiliary contacts.
 6. Push buttons.
 7. Selector switches.
- C. Controller Disconnect Switches: Fused switch Adjustable instantaneous-trip circuit breaker integrally mounted adjacent to and interlocked with controller.
1. Auxiliary Contacts: Integral with disconnect switches to de-energize external control-power source.

- D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.
 - 1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. Control-Power Source: 120-V branch circuit.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to evaluate functions of solid-state trip devices without removal from panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of the trim is 74 inches above the finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub five 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated phenolic nameplate mounted with corrosion-resistant screws. Nameplate colors shall be consistent.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Evaluate insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.
- C. Load Balancing: After 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.
- D. Infrared Scanning: Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of 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 panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- G. FEEDER INSULATION RESISTANCE TESTING
 - 1. All current carrying phase conductors and neutrals shall be evaluated as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500-volt megger. The procedures listed below shall be followed:
 - a. Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor.

- b. After all fixtures, devices and equipment are installed and all connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then evaluate each one separately on the panel and until the low readings are found. The contractor shall correct troubles, reconnect, and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
- c. At final inspection, the contractor shall furnish a megger and show the engineers and State Construction Office representatives that the phase, neutral, and ground bus within panels comply with the above requirements. He shall also furnish a hook-on type of ammeter and voltmeter to take current and voltage readings as directed by the representatives.

H. GROUND SYSTEM TESTING

1. Upon completion of installation of the electrical grounding and bonding systems, the ground resistance shall be evaluated with a ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, appropriate action should be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods. (The compliance should be demonstrated by retesting.)

I. CIRCUIT BREAKER TESTS

1. For services 1000 amperes and larger, the following tests should be performed on the service circuit breakers and the distribution circuit breakers. Testing shall be performed by a qualified factory technician at the job site. All readings shall be tabulated:
 - a. Phase tripping tolerance (within 20% of U/L requirements).
 - b. Trip time (per phase) in seconds.
 - c. Instantaneous trip (amps) per phase.
 - d. Insulation resistance (in megaohms) at 100 volts (phase to phase, and line to load).
 - e. Set final trip functions to match the engineers approved overcurrent protection device coordination and arc flash study.
 - f. Ground fault protection on circuit breakers shall be evaluated in the field in accordance with the NEC and properly calibrated and set to match the coordination and arc flash studies.
 - g. List all breakers' settings on the as-built drawings.

J. GROUND FAULT PROTECTION SYSTEM

1. The ground fault protection on the new circuit breakers (if provided) shall be performance evaluated in the field and properly calibrated and set in accordance with the coordination study.

K. DOCUMENTATION

1. All tests specified shall be completely documented indicating time of day, date, temperature, and all pertinent test information.
2. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project.

- L. The ground fault protection on the new circuit breakers (if provided) shall be performance evaluated in the field and properly calibrated and set in accordance with the coordination study.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match the original finish.

3.6 SHORT CIRCUIT STUDY:

- A. A complete short circuit and protection coordination study with coordination plots for each medium and low voltage distribution system shall be provided. The studies shall include the power company's system and relay characteristics, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, impedance diagrams, conclusions, and recommendations. A ground fault study shall be provided for the low voltage system, which shall include the associated zero sequence impedance diagrams. Short circuit momentary duties, when applicable, and interrupting duties shall be calculated on the basis of an assumed fault at each medium voltage switchgear line-up, low voltage switchgear line-up, switchboard, distribution panelboard, pertinent branch circuit panelboard, generator, and other significant locations throughout the systems. The short circuit tabulations shall include the fault impedances, X to R ratios, asymmetry factors, KVA symmetrical and asymmetrical fault currents.
- B. The coordination plots required shall graphically indicate the coordination proposed for the several systems centered on full scale log forms. The coordination plots shall include complete titles, representative one-line diagrams and legends, associated power company's relay or system characteristics, medium voltage fuses and relays, significant equipment starting characteristics, complete parameters for transformers, complete operating bands for low voltage switchgear or switchboard circuit breaker trip devices, and the associated system load protective devices. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time dial settings and pickup settings required. The long-time region of the coordination plots shall indicate a complete tap scale for each medium voltage relay, full load current and 150, 400 or 600 percent full load current transformer parameters and designate the pickups required for the low voltage circuit breakers. The brief time region shall indicate the medium voltage relay instantaneous elements, the magnetizing inrush, ANSI withstand thermal and mechanical transformer parameters, fuse manufacturing tolerance bands, and significant symmetrical and asymmetrical fault currents. Each primary protective device required for a delta-grounded wye connected transformer shall be selected so the characteristic or operating band is within the transformer parameters and shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line to ground faults. The transformer damage curve shall be included for each transformer. Low voltage power circuit breakers shall provide long-time, long-time delay, short time, short time delay, ground fault, ground fault delay, and I^2t in/out settings with coordination plots and shall be separated from each other and the associated primary protective device by a 16 percent current margin for coordination and protection in the event of secondary line to line or line to ground fault. Medium voltage relays shall be separated by a 0.4 second time margin when the maximum three phase fault flows, to assure proper selectivity. The protective device characteristics or operating band shall reflect the actual symmetrical and asymmetrical fault currents sensed by the device.
- C. The contractor shall note that the drawings and specifications indicate the general requirements for the equipment, the medium voltage and low voltage equipment, but additional specific

characteristics of equipment furnished shall be determined in accordance with the results of the short circuit and protection coordination study. The equipment design discrepancies and the proposed corrective modifications, if required, shall be submitted with the short circuit and protection coordination study with any variations clearly noted on the subsequent shop drawings. Necessary field settings, adjustments, and minor modifications for conformance with the approved short circuit and protection coordination study shall be accomplished by the particular manufacturer or by the Contractor without additional expense to the Owner. However, should equipment specified be outside the parameters required by this study, a change order to modify the equipment shall be issued if the engineer's review warrants such a change. Equipment shop drawings shall not be submitted until the short circuit and protection coordination study has been reviewed by the Owner's engineer.

D. Arc-Flash labels shall be printed per OSHA requirements and shall be installed by the contractor.

3.7 POINT SETTINGS:

- A. The Electrical Contractor shall set and calibrate all target points and settings indicated on the approved coordination study prior to energizing and evaluating the system.
- B. The study shall require the Electrical Contractor to provide the following information:
 - 1. Length, type, resistance, reactance of all cables both medium and low voltages.
 - 2. Fuse curves as required.
 - 3. Utility information.

END OF SECTION 26 24 16

.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. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Receptacles with integral surge suppression units.
 - 4. Wall-box motion sensors.
 - 5. Isolated-ground receptacles.
 - 6. Snap switches and wall-box dimmers.
 - 7. Solid-state fan speed controls.
 - 8. Wall-switch and exterior occupancy sensors.
 - 9. Communications outlets.
 - 10. Pendant cord-connector devices.
 - 11. Cord and plug sets.
 - 12. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.
- B. Related Sections include the following:
 - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

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. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.
- F. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- 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 NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

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. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Receptacles shall be industrial specification grade or heavy-duty grade meeting NEMA WD 1, NEMA WD 6, DSCC W-C-596G, UL-498 and shall be approved third-party listed.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).
2. Receptacles shall have side wired terminals with brass screws and hex head grounding screw.
- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; CR 5253IG.
 - b. Leviton; 5362-IG.
 - c. Pass & Seymour; IG6300.
 - 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; TR8300.
 - b. Hubbell; HBL8300SG.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; 63H.

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through h type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.
 - c. Leviton

2.4 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

- B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; IG2310.
 - b. Leviton; 2310-IG.
 - c. Pass & Seymour
 - d. Cooper
 2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 2. 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 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
 2. Wall switches shall have a side wired terminals with brass screws and hex head grounding screw.

3. Toggle switches shall have quiet operating mechanisms without the use of mercury switches. All switches shall be listed by an approved third-party agency, approved for the voltage and amperage indicated.
- C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.

2.8 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. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."
- D. 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.

2.9 FAN SPEED CONTROLS

- A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
 - 1. Continuously adjustable slider,
 - 2. Three-speed adjustable slider, 1.5 A.

2.10 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6111 for 120 V, 6117 for 277 V.
 - b. Hubbell; WS1277.
 - c. Leviton; ODS 10-ID.
 - d. Pass & Seymour; WS3000.
 - e. Watt Stopper (The); WS-200.
 - 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.
- B. Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; AT120 for 120 V, AT277 for 277 V.
 - b. Leviton; ODS 15-ID.
 - c. Watt Stopper
 - 2. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.
- C. Long-Range Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP1600WRP.
 - b. Leviton; ODWWV-IRW.
 - c. Pass & Seymour; WA1001.
 - d. Watt Stopper (The); CX-100.
 - 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft.

D. Long-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

E. Wide-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP120HBRP.
 - b. Leviton; ODWHB-IRW.
 - c. Pass & Seymour; HS1001.
 - d. Watt Stopper (The); CX-100-3.
2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

F. Exterior Occupancy Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; PS200-10.
 - b. Watt Stopper (The); EW-100-120.
 - c. Hubbell
2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.11 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following: Cooper, Pass & Seymour, Hubbell, Leviton.
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
 - c. Hubbell
 - d. Pass & Seymour
3. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following: Cooper, Pass & Seymour, Hubbell, Leviton.
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 3562.
 - b. Leviton; 40595.
 - c. Hubbell
 - d. Pass & Seymour
3. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.12 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: See the Plans.
 3. Material for Unfinished Spaces: See the plans.
 4. Material for Damp Locations: Die Cast Metal with spring-loaded lift cover and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R die cast metal with lockable cover.

2.13 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: See the Plans.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: See the Plans.

2.14 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
 3. Square D/ Schneider Electric.
 4. Thomas & Betts Corporation.
 5. Wiremold Company (The).
- B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
2. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.15 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the Cooper, Pass & Seymour, Hubbell, Leviton.
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.

2.16 SERVICE POLES

- A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 1. Poles: Nominal 2.5-inch- square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 3. Finishes: Satin-anodized aluminum.
 4. Wiring: Sized for a minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
 5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
 6. Voice and Data Communication Outlets: Blank insert with bushed cable opening.

2.17 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 1. Wiring Devices Connected to Normal Power System: See the Plans., unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. TVSS Devices: Blue.
 4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. 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 the 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 just 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 all devices that have been in temporary use during construction or that show signs that they 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, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the 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.
 - 10. Receptacles shall not utilize "push-in modular" connectors.
- E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- 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 online 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, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped, or engraved machine printing with black-filled lettering on the face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Evaluate Instruments: Use instruments that comply with UL 1436.
 2. Evaluate Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED 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 not acceptable.
 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. The 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 them with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

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. Cartridge fuses rated 600 V and less for use in switches panelboards switchboards controllers and motor-control centers.
 - 2. Spare-fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Let-through current curves for fuses with current-limiting characteristics.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Ambient temperature adjustment information.
- D. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- 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 NEMA FU 1.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 5 percent of each fuse type and size, but at least 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE-FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Service Entrance: Class L, time delay J, fast acting J, time delay T, fast acting.
- B. Feeders: Class L, time delay J, time delay RK5, time delay.
- C. Motor Branch Circuits: Class RK5, time delay.
- D. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on the inside door of each fused switch.

END OF SECTION 262813

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Bolted-pressure contact switches.
 - 4. High-pressure, butt-type contact switches.
 - 5. Molded-case circuit breakers.
 - 6. Molded-case switches.
 - 7. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. UL listing for series rating of installed devices.
 - 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.

- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports including the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current curves, including selectable ranges for each type of circuit breaker.
- H. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 QUALITY ASSURANCE

- A. 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.

- 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 NFPA 70.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spares: For the following:
 - a. Potential Transformer Fuses: 3
 - b. Control-Power Fuses: 3
 - c. Fuses and Fusible Devices for Fused Circuit Breakers: 3
 - d. Fuses for Fusible Switches: 3
 - e. Fuses for Fused Power Circuit Devices: 3
 - 2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

- B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- C. Non fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 FUSED POWER CIRCUIT DEVICES

- A. Bolted-Pressure Contact Switch: UL 977; operating mechanism shall use a rotary-mechanical-bolting action to produce and maintain high-clamping pressure on the switch blade after it engages the stationary contacts.

1. Manufacturers:

- a. Boltswitch, Inc.
- b. Eaton Corporation; Cutler-Hammer Products.
- c. Pringle Electrical Mfg. Co.
- d. Siemens Energy & Automation, Inc.
- e. Square D/Group Schneider.

2.4 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. Moeller Electric Corporation.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

- B. Molded-Case Circuit Breaker: NEMA AB 1, 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. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
- C. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 5. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 6. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 8. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- E. Molded-Case Switch Accessories:
1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.

2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. Provide "dummy" trip unit where required for proper operation.
5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.

2.5 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. The anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, evaluate, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Evaluate mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.
 - 3. Infrared Scanning:
 - a. Initial Infrared Scanning: After Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Completion.
 - c. Instruments, Equipment and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

- A. On completion of installation, vacuum dirt, and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 28 16

SECTION 26 43 13 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 TVSSs for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for devices with integral TVSSs.
 - 2. Division 26 Section "Switchboards" for factory-installed TVSSs.
 - 3. Division 26 Section "Panelboards" for factory-installed TVSSs.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. TVSS: Transient voltage surge suppressor.
- D. SPD: Surge Protection Device

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
 - 1. UL 1283.
 - 2. UL 1449.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports, including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.

- E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Special warranties specified in this Section.
- G. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing 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.
- B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- 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.
- E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.6 PROJECT CONDITIONS

- A. 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 the Architect's written permission.
- B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protection devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of final acceptance of work.
- B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advanced Protection Technologies, Inc.
 2. Current Technology, Inc.
 3. Surge Suppression Incorporated.
 4. Cutler-Hammer, Inc.; Eaton Corporation.
 5. Entelec International.
 6. Intermatic, Inc.
 7. LEA International.
 8. Leviton Mfg. Company Inc.
 9. Liebert Corporation; a division of Emerson.
 10. Northern Technologies, Inc.

11. Siemens Energy & Automation, Inc.
12. Square D; Schneider Electric.
13. Sutton Designs Inc.
14. Transtector Systems, Inc.
15. Tycor; Cutler-Hammer, Inc.
16. United Power Corporation.

2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- B. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. Redundant replaceable modules.
 6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 8. LED indicator lights for power and protection status.
 9. Audible alarm, with silencing switch, to indicate when protection has failed.
 10. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 11. Surge-event operations counter.
- C. Peak Single-Impulse Surge Current Rating: 240 kA per phase.
- D. Connection Means: Permanently wired.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 400 V for 208Y/120.
 2. Line to Ground: 400 V for 208Y/120.
 3. Neutral to Ground: 400 V for 208Y/120.
- F. Protection modes and UL 1449 SVR for voltages of 480, 3-phase, 4-wire, circuits shall be as follows:
1. Line to Line: 1000 V for 480 V.
 2. Line to Ground: 1000 V for 480 V.

2.3 PANELBOARD SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- B. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. Redundant replaceable modules.
 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 7. LED indicator lights for power and protection status.
 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 9. One set of dry contacts rated at 5 A and 250-V, ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 10. Surge-event operations counter.
- C. Peak Single-Impulse Surge Current Rating: 80 kA per phase.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 400 V for 208Y/120.
 2. Line to Ground: 400 V for 208Y/120.
 3. Neutral to Ground: 400 V for 208Y/120.
- E. Protection modes and UL 1449 SVR for voltages of 480, or 600, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 1000 V for 480 V.
 2. Line to Ground: 800 V for 480 V.

2.4 SUPPRESSORS FOR ELECTRONIC-GRADE PANELBOARDS

- A. Surge Protection Device Description: Sine-wave-tracking type, panel-mounted design with the following features and accessories:
1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
 4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

- B. Peak Single-Impulse Surge Current Rating: 120 kA per phase.
- C. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. Line to Neutral: 400 V for 208Y/120.
 - 2. Line to Ground: 400 V for 208Y/120.
 - 3. Neutral to Ground: 400 V for 208Y/120.
- D. Protection modes and UL 1449 SVR for voltages of 480, or 600, 3-phase, 3-wire, delta circuits shall be as follows:
 - 1. Line to Line: 1000 V for 480 V.
 - 2. Line to Ground: 800 V for 480 V.

2.5 PLUG-IN SURGE SUPPRESSORS

- A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. LED indicator lights for reverse polarity and open outlet ground.
 - 3. Circuit breaker and thermal fusing. When protection is lost, the circuit opens and cannot be reset.
 - 4. Circuit breaker and thermal fusing. Unit continues to supply power if protection is lost.
 - 5. Close-coupled direct plug-in.
 - 6. Rocker-type on-off switch illuminated when in the on position.
 - 7. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and No. 4.
- B. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
- C. Protection modes and UL 1449 SVR shall be as follows:
 - 1. Line to Neutral: 475 V.
 - 2. Line to Ground: 475 V.
 - 3. Neutral to Ground: 475 V.

2.6 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

- B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multipole, 60-A circuit breaker as a resolute disconnect for suppressor, unless otherwise indicated.

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect panelboards to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, evaluate, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:
- C. Testing: Perform the following field tests and inspections and prepare test reports:
 - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 43 13

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 26 09 26 "Lighting Control Panelboards" for panelboards used for lighting control.
3. Section 26 09 33 "Central Dimming Controls" or Section 26 09 36.19 "Standalone Multipreset Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.
4. Section 26 09 43.16 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, arranged by designation.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps.

D. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved:

B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

C. Product Certificates: For each type of luminaire.

D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Final Inspection and acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE 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.

- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. CRI of 80. CCT of 4000 K.
- F. Rated lamp life of 50,000 hours.
- G. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- H. Internal driver.
- I. Nominal Operating Voltage: As circuited on the drawings.
 - 1. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
 - 1. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.

2.4 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.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports: Sized and rated for luminaire weight.
- E. Flush-Mounted Luminaire Support: Secured to outlet box.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
 - 2. Ceiling mount with pendant mount with 5/32-inch diameter aircraft cable supports adjustable to 120 inches.
- H. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- I. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Secure with a screw at each corner to a MAIN ceiling runner.
- J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

- K. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Evaluate for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and/or generator life safety power and retransfer to normal.
 - a. Emergency lighting levels are to be evaluated in all areas to demonstrate the minimum average levels of 1.0 footcandles along the egress path. Demonstrate to the SCO inspector and agent of the engineer of record using a light meter and document the recorded levels.
- B. Battery: Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be evaluated for 90 minutes. The test shall demonstrate that the batteries conform to the requirement of NEC 700.12 (I). The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced and evaluated again. A copy of the test report shall be sent to the State Construction Office.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 51 19

SECTION 26 52 19 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by the manufacturer.
 - b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 4. Structural members to which equipment will be attached.
 5. Size and location of initial access modules for acoustical tile.
 6. Items penetrating finished ceiling including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Ceiling-mounted projectors.
 - e. Sprinklers.
 - f. Access panels.
 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
2. Warranty Period for Emergency drivers and Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- 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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with NECA/IESNA 500, "Standard for Installing Interior Commercial Lighting Systems."
- F. Comply with NECA/IESNA 502, "Standard for Installing Industrial Lighting Systems."

- G. Comply with UL 8750, "Standard for Safety for Light Emitting Diode (LED) Equipment for Use in Lighting Products."
- H. Comply with IESNA LM-79, "Electrical and Photometric Measurements of Solid-State Lighting Products".
- I. Comply with IESNA LM-80, "Measuring Lumen Maintenance of LED Light Sources."
- J. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with driver.
 - 1. Emergency Connection: Operate LED lamp(s) continuously at an output of 1100 lumens upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. The lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, the relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
 - 4. Evaluate Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 5. Battery: Sealed, maintenance-free, nickel-cadmium type, with minimum of 90 minutes operating endurance. Must have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0-degree C to 60-degrees C. Battery operated luminaires installed in cold environments, including exterior , shall have low temperature option.
 - 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 7. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response. See plans for locations.
 - 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- K. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate LED lamping continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. The lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, the relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Battery: Sealed, maintenance-free, nickel-cadmium type, with minimum of 90 minutes operating endurance. Must have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0-degree C to 60-degrees C. Battery operated luminaires installed in cold environments, including exterior , shall have low temperature option.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
6. Evaluate Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response. See plans for requirements.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units:
- B. Single Manufacturer: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.4 External emergency power unit EXIT signs.

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated in Drawings.
 2. Operating at nominal voltage of see plans.
 3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
 4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
 5. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs and provide additional capacity in LED power supply battery for power connection to remote unit.

- b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 MATERIALS

A. Metal Parts:

- 1. Free of burrs and sharp corners and edges.
- 2. Sheet metal components shall be steel unless otherwise indicated.
- 3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

- 1. Smooth operating, free of light leakage under operating conditions.
- 2. Designed to permit relamping without the use of tools.
- 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

2.6 METAL FINISHES

- A. 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.

2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Evaluate for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 26 52 19

SECTION 26 56 19 – LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 General Notes:

- A. All exterior Light Poles, 12ft and taller, shall be UL listed or approved 3rd party listed.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:

1. Exterior solid-state luminaires are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

1.4 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with [IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79.

- a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Product Schedule: For luminaires and lamps. Use the same designations indicated on Drawings.
- C. Delegated-Design Submittal: For luminaire supports.
1. Include design calculations for luminaire supports and seismic restraints.
- D. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.6 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. Luminaires.
 2. Structural members to which equipment and luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.
 7. Building features.
 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
1. Luminaire.
 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Source quality-control reports.

- G. Sample warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by the manufacturer.
- F. Comply with IEEE C2, "National Electrical Safety Code."
- G. Comply with NFPA 70, "National Electrical Code."
- H. Comply with NECA/IESNA 501, "Standard for Installing Exterior Lighting Systems."
- I. Comply with UL 1598, "Standard for Luminaires."
- J. Comply with UL 8750, "Standard for Safety for Light Emitting Diode (LED) Equipment for Use in Lighting Products."
- K. Comply with IESNA LM-79, "Electrical and Photometric Measurements of Solid-State Lighting Products".
- L. Fixtures will be required to be DesignLights Consortium compliant (DLC). Fixtures specified must meet DLC certification or supplier will be responsible for submitting an "equal" fixture to the listed schedule fixture.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated in Drawings.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

2.3 LUMINAIRE 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.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. UL Compliance: Comply with UL 1598 and listed for wet location.
- D. CRI of minimum 80. CCT of 4000 K.
- E. L70 lamp life minimum of 50,000 hours.

- F. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- G. Internal driver. Provide a quick disconnect for driver and diode board.
- H. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.4 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.5 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 -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 - a. Color: Dark bronze.
- D. 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.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, 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 luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is complete, clean luminaires are used for temporary lighting and installing new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
- H. Coordinate layout and installation of luminaires with other construction.
- I. Adjust luminaires that require field adjustment or aiming. [Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.]
- J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use it in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." 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 05 53 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s), as applicable to the specific luminaire use:
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.9 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of the date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 56 19

Division 27 – Communications

SECTION 27 53 19 - EMERGENCY RESPONDER RADIO ANTENNA/REPEATER SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish, install, and evaluate a complete and operating Emergency Responder Radio Antenna/Repeater System.

1.02 SECTION INCLUDES

- A. This Section includes the requirements for an Emergency Responder Radio Antenna/Repeater System for the purposes of assuring reliable communications by providing minimum signal strength and minimum voice quality in 95% of all areas of the building.
- B. Components Include
 1. Bi-directional amplifiers (“BDA” or “BDAs”)
 2. Donor antenna
 3. Indoor coverage antennas
 4. Distributed Antenna System (“DAS”)
 5. Coaxial cable
 6. Splitters and directional couplers
 7. Backup power
 8. All other equipment and components necessary for a complete and functioning Emergency Responder Radio Antenna/Repeater System.

1.03 RELATED CODES AND STANDARDS

- A. All aspects of system design, installation, testing and maintenance shall comply with the current versions of the following:
 1. NFPA 1 – The National Fire Code (including Annex O from 2009)
 2. NFPA 70 – The National Electrical Code
 3. NFPA 101, Life Safety Code
 4. NFPA 72-07 National Fire Alarm Code
 5. FCC 47 CFR Part 90.219: Private Land Mobile Radio, Use of Signal Boosters
 6. Section 510 International Fire Code
 7. TSB-88-B, The Telecommunications Industry Association's (TIA) Technical Service Bulletin 88
 8. Equipment manufacturers’ installation and maintenance specifications
- B. The requirements established by the AHJ in effect at the time of system installation supersede the specifications in this section. It is the contractor’s responsibility to assure the installed system complies with all currently applicable local, national and industry codes as adopted by the AHJ.

1.04 DEFINITIONS

- A. Definitions:
 1. Authority Having Jurisdiction (“AHJ”): The local authority responsible for establishing requirements for Emergency Responder Radio Coverage Systems consistent with local codes and policies.

2. Critical Areas: Spaces within a building that require an extra assurance of radio coverage. These areas include emergency command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets and other areas deemed critical by the AHJ.
3. Contractor: The entity bidding on the project.
4. Owner: The entity who commissioned the project and will own the finished building.
5. Bi-Directional Amplifier or “BDA”: An electronic device designed to provide amplification of uplink and downlink channels of radio services. These devices can be configured for operation on specific narrow-band frequencies, on a specific frequency band or on multiple frequency bands.
6. Distributed Antenna System (“DAS”): A network typically consisting of coaxial cable, fiber cable, splitters, taps, couplers, and antennas designed for delivering radio signals to and from spatially separated antenna nodes or other intentional radiators, such as leaky coaxial cable, within a building or area where traditional off-air signal delivery is compromised.
7. Backup Power Supply: A secondary power source to support uninterrupted system operation in case of a failure of the primary power source. This system is configured to automatically transfer its load upon failure and restoration of the primary power source.
8. Donor Antenna: An antenna installed and directed to intercept over-the-air downlink and uplink radio signals on one or more channels from a specific base station or fixed repeater facility. A donor antenna usually is located on a roof or other location where reliable signal reception can be achieved. This antenna conveys radio signals delivered to and from a distributed antenna system.
9. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems specifically for fire, emergency medical services or law enforcement agencies within a structure where radio reception may otherwise be too weak for reliable communications.
10. Delivered Audio Quality Definitions (“DAQ”): This is a universal standard adopted from TSB-88-B and often cited in system designs and specifications.
 - a. DAQ 1: Unusable, speech present but unreadable.
 - b. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise/distortion.
 - c. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise/distortion.
 - d. DAQ 3.4: Speech understandable with repetition only rarely required. Some noise/distortion
 - e. DAQ 4: Speech easily understood. Occasional noise/distortion.
 - f. DAQ 4.5: Speech easily understood. Infrequent noise/distortion.
 - g. DAQ 5: Speech easily understood.
11. Active System Components: System components, such as amplifiers, which require power. These components typically are utilized to provide amplification or “gain” to signals on the system.
12. Passive System Components: These components introduce signal loss in an RF system. Splitters, combiners, taps, directional couplers, and cable are examples of passive system components.
13. Passive Intermodulation (“PIM”): Unwanted signals generated due to non-linear connections or junctions in an RF path.
14. FCC: Federal Communications Commission
15. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

- 16. Public Safety/First Responder: Public Safety or First Responder agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
- 17. RF: Radio Frequency

1.05 Design Approval

Plans shall be submitted and approved by the AHJ prior to installation. The Owner will submit the proposed design along with the full building plans as part of its Scheduled Plan Review. The following information shall be provided by the system designer/Contractor:

- 1. Detailed drawings showing the location of the amplification equipment and associated antenna systems.
 - a. System Block Diagram includes the donor antenna(s), BDA(s), passive components, and in-building antennas. Include the RF link budget.
 - b. Overlay of the system design on building floor plan drawings
- 2. Manufacturer's data sheets on all equipment to be installed.

1.06 PERFORMANCE REQUIREMENTS

A. Frequencies

- 1. *Two* sets of frequencies are to be utilized on the system.
- 2. The following FCC-licensed facilities are to be carried on the system:

FCC Call Sign	Downstream/ Base-to-mobile Frequency	Upstream/ Mobile-to-base Frequency	Channel Bandwidth
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- 3. Transmissions on each set of frequencies must individually meet the coverage, minimum signal, and minimum voice quality requirements.
- 4. Frequency Changes: Equipment selected for this system must be capable of being configured to different frequency pairs in the Public Safety frequency bands. These changes may later be necessary due to future additions or optimization of radio systems maintained by the AHJ.
- 5. It is the responsibility of the contractor to confirm the frequencies in use with the AHJ before proceeding with the system installation.

B. Minimum Received Signal Levels

- 1. Downstream signals: -95 dBm; The minimum signal strength that shall be received inside the building.
- 2. Upstream signals: -95 dBm: The minimum signal strength that shall be received at the Authority's repeater site.
- 3. Receiving signals in the building and at the Authority's repeater facility shall have a minimum Signal-to-Noise ratio of 15 dB.
- 4. Minimum received signal levels must be maintained regardless of seasonal and occasional signal path propagation conditions including those caused by weather and seasonal foliage changes.
- 5. Donor antennas utilized for the system must be directional and directed toward the respective repeater(s).
- 6. The minimum isolation between the donor antenna and system antennas shall be 15 dB or higher as necessary to prevent system oscillation based on the operating parameters required to meet the minimum coverage requirements.

- C. Coverage
1. Signals at or above the minimum levels are to be receivable to and from 95% of all areas within the building. Spaces or rooms defined as critical areas require 99% coverage. For the purposes of this Section, 95% coverage is considered to be all areas of the building.
 2. The contractor is responsible for providing a system design and installation that provides enhancement only to those areas of the building where existing off-air service does not meet the minimum levels as described above. Signal strength surveys to confirm coverage enhancement requirements are the responsibility of the contractor. Care must be taken in engineering a system that will not cause interference with the Authority's radio system outside the building.
- D. Equipment Locations
1. BDA: Wall space has been allocated for system electronic and headend components in the upper-level Telecommunication Room (I.T.), (T.R.). The wall space is 4 feet wide by 8 feet tall.
 2. Donor Antenna(s): A preferred antenna location on the building roof has been specified by the owner. The contractor is responsible for providing and installing the antenna(s), mounting hardware, roof penetration and conduit from the antenna mast to the Fire Control Room. Provide a 4" conduit from the room housing the BDA to the roof. At the roof level provide a weather-head on the conduit. Coordinate roof penetrations and sealing with the General Contractor.
 3. Electronic components, including secondary power, shall be designed for operation in a NEMA 4 non-vented weather tight box. These components must be capable of reliable operation at temperatures ranging from -22 degrees F to +120 degrees F (-30 degrees C to +50 degrees C) minimum.
- E. System Power Source
1. A resolute, 120-volt, 20 A circuit has been specified as primary power for the BDA or any other required electronic components located in the Telecommunication Room (I.T.), (T.R.). If additional power is required at this or other locations such must be clearly specified as part of the submitted system design. The electrical contractor shall include the cost of additional power sources in the bid.
 2. A secondary automatic transfer power source for all active electronic components in the system shall be provided. Supplier shall provide battery back-up for 24 hours of operation minimum. When the back-up system includes a generator, provide a UPS to support the 100 percent operation of the system for a minimum of two (2) hours. The emergency generator system serves the UPS system and shall provide power to the UPS system for a minimum of 24 hours. If the back-up system does not include a generator provide a UPS system to support the 100 percent operation of the system for a minimum of twenty-four (24) hours.
- F. Mode of Operation
- The system shall be designed for continuous, always-on service. A malfunction alarm for the BDA shall be provided and connected to the building fire alarm system.
- G. System Frequency Response
- All cable and passive electronic components shall have a minimum pass band of 400 – 2700 MHz. Systems that utilize a higher band, 698-2700 MHz shall be permitted if the band falls within that range.
- H. Survivability

1. Physical Protection: All wiring and cabling, with the exception of radiating cable and antenna jumper cables measuring less than 2 feet in length, shall be installed in conduit.
 2. All exposed cable, including flexible jumper cables, shall be plenum rated, utilizing a jacket of non-halogenated, fire retardant polyolefin.
 3. Survivability levels shall be verified with local AHJ prior to construction. A survivability level of 2 (2 hour rated cabling) is required unless otherwise indicated by the AHJ.
- I. Compatibility
Provide class-A BDA.
- J. RF Exposure
The system shall meet the RF exposure guidelines of FCC Bulletin OET 65.

1.07 SUBMITTALS

- A. Submittal Requirements with Bid Response
1. Product Data: Submit the manufacturer datasheets for the following components:
 - a. Donor Antennas
 - b. Coverage Antennas and/or Radiating Cable
 - c. Coaxial Cable and Connectors
 - d. Passive Devices including Splitters, Taps, Combiners and Couplers
 - e. Bi-Directional Amplifiers (BDA)
 - f. Secondary Power Supplies
 - g. Surge Protection
 2. Shop Drawings
 - a. System Block Diagram includes the donor antenna(s), BDA(s), passive components, and in-building antennas. Include the RF link budget for Uplink and Downlink Path. Provide all assumptions.
 - b. Overlay of the system design on building floor plan drawings
 - c. Overlay on floor plan drawings of the predicted signal strength within the coverage area indicating, at a minimum, the -95 dBm downlink (base to mobile) signal strength for all coverage areas.
 - d. Building elevation and plan views depicting the location of any outdoor antennas associated with the proposed system. Include the antenna centerline height above building, orientation, mounting method, cabling, conduit route and the location of all external grounding connections.
 - e. BDA and Secondary Power Supply installation. Include plan and elevation views indicating equipment dimensions, mounting methods, enclosure type, cable and conduit routing, voltage required, power required, label locations and required clearance from other equipment. Identify each piece of equipment by brand, model number and equipment type.
 - f. Drawings and block diagrams are to be provided in AutoCAD format and accompanied by two (2) printed copies.
 - g. Shop drawings shall be 8.5-inch x 11 inch or greater, scaled, or dimensioned, with dimensions or scale clearly noted. Floor plan drawings shall be 24-inch x 36 inch minimum with drawings scaled to legible size.
 - h. All components shall be consistently named or labeled for reference in other drawings, diagrams, and tables.
 3. Other Submissions

- a. Specify antenna grounding and surge protection in accordance with NEC Article 810 and these specifications.
 - b. Specify the backup/secondary power source and include calculations to ensure the backup power requirements as specified in this standard are met.
 - c. List of Individuals Responsible for the system design, planning and installation along with their qualifications and experience.
- B. Submittal Requirements Prior to the Start of System Installation
1. Documentation confirming the latest information from the AHJ of the frequencies to be supported by the system.
 2. List of any approved system design changes required since the original bid and the reason for each change. This list includes any design changes required for approval by the AHJ.
 3. Updated Product Data, Shop Drawings and Diagrams reflecting any changes.
 4. Bill of Materials (“BOM”)
 5. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be installed.
 6. System Installation Schedule as approved by the Owner, General Contractor and AHJ.
- C. Submittal Requirements at Project Close Out
1. As-Built Drawings of all items required and, in the formats, listed in item A and B above.
 2. Evaluate Reports
 - a. In-Building Coverage Test Results
 - b. Donor Antenna Isolation
 - c. Spectrum Analysis Report demonstrating only the intended frequencies are being carried on the system.
 - d. Spectrum Analysis Report demonstrating no spurious oscillations, PIM or other intermodulation products are being produced that would affect other services or system performance.
 - e. Sweep test results of all coaxial cable runs.
 - f. System Malfunction Alarm and its connection to the fire alarm panel.
 3. Record of system operating parameters including:
 - a. Signal levels received at the donor antenna.
 - b. Signal levels at the input and output of the BDA.
 - c. BDA Gain Settings
 4. Operation and Maintenance Data: Submit hardware and software manuals for all products including all features and operating parameters.
 5. Warranty Documents:
 - a. Submit for all manufactured components utilized in the system.
 - b. Submit Manufacturer’s Extended Warranty
 - c. Submit Contractor’s System Warranty
 6. Submit the agenda for the training class along with copies of handouts to be utilized in the class.
 7. Compile the items listed in this section into a single Operations and Maintenance Manual to be provided in electronic format. Include drawings and block diagrams in Adobe Acrobat (.pdf) and in AutoCAD format. Include a section containing a copy of the latest maintenance, testing, and reporting requirements of the AHJ.

1.08 QUALITY ASSURANCE

- A. Minimum Qualifications of Personnel
 - 1. Engineering and Design:
 - a. A valid Professional Engineering Certification and Certification of in-building system training issued by the manufacturer of the equipment being installed or
 - b. Approval issued by the AHJ.
 - c. Include GROOL requirement as stated by the latest IFC code.
 - 2. Installer Qualifications:
 - a. Minimum five years of experience installing systems of similar scope and complexity.
 - b. Certified by the manufacturer of the BDA equipment to be installed.
- B. All equipment shall be UL listed and labeled, and in accordance with applicable NEMA and ANSI Standards.
- C. All parts of racks and enclosures shall be welded or assembled with paint piercing ground washers, grounding strip and bonding jumper.

1.09 WARRANTY

The contractor shall warrant system performance as specified in this section for one year starting on the date of final system acceptance.

1.10 MAINTENANCE AND ANNUAL TESTING

- A. The contractor shall provide the first full year of maintenance for the system. The term of this maintenance period begins on the date of final system acceptance.
- B. Maintenance shall include.
 - 1. 24-hour by 7-day emergency response within two hours after notification
 - 2. Annual testing
- C. Annual Tests
 - 1. BDA Operating Parameters:
 - a. Record signal and power levels.
 - b. Review self-diagnostics and other items as recommended by the manufacturer.
 - c. Note any parameter changes from previous tests, investigate causes.
 - 2. Backup/Secondary Power Supply
 - a. Record voltage and charging of batteries before testing under load.
 - b. Evaluate batteries under full load for at least one hour or until the integrity of the batteries can be determined.
 - 3. Evaluate system malfunction alarm and its connection to the fire alarm panel.
 - 4. Maintain documentation on-site with a backup copy off-site.

PART 2 PRODUCTS

1.02 MANUFACTURERS

Subject to compliance with the requirements of this Section, manufacturers of the products that may be utilized in the system include, but are not limited to, the following:

- 1. CommScope/Andrew
- 2. Cobham

3. PCTEL
4. Times Microwave
5. RFS – Radio Frequency Systems
6. Microlab/FXR
7. Bird Technologies
8. EMR Corp.
9. Galtronics
10. ADRF
11. Notifier
12. RSI

1.03 SYSTEM COMPONENTS

A. Donor Antennas

1. Electrical:
 - a. Frequency band: covering the frequencies specified by the AHJ.
 - b. VSWR \leq 1.5:1
 - c. Gain: \geq 10.0 dBi
 - d. Maximum Input Power: 100 watts
 - e. Polarization: Vertical
 - f. Front-to-back ratio: \geq 15 dB.
 - g. Vertical Beamwidth: \leq 30 degrees
 - h. Horizontal Beamwidth: \leq 60 degrees
 - i. Impedance: 50 Ω
2. Mechanical:
 - a. Connector: 50 Ω type N Female
 - b. Mounting: Mast on a non-penetrating mount utilizing concrete block ballast
 - c. Grounding/Bonding: Pursuant to NFPA 70 NEC Article 810 requirements
3. Environmental:
 - a. Temperature: -40°C to +60°C
 - b. Lightning Protection: Direct Ground
 - c. Maximum Rated Wind Velocity: 125 mph
4. Antenna Cable:
 - a. All exposed cable shall have a UV stable black jacket for protection from sunlight.
 - b. Cable feed to the BDA shall be ½” copper corrugated outer conductor foam dielectric coax.
 - c. Weatherproofing: exposed connectors protected from the effects of weather
 - d. Rigid conduit between the Donor location and BDA location shall be provided and installed by the contractor.

B. Omni-Directional In-Building Coverage Antennas

- a. Frequency band: 698-900 MHz
- b. VSWR \leq 1.8:1
- c. Gain: \geq 1.0 dBi
- d. Maximum Input Power: 25 watts

- e. Polarization: Vertical
 - f. Vertical Beamwidth: ≥ 65 degrees
 - g. Horizontal Beamwidth: 360 degrees
 - h. PIM: < -150 dBc
 - i. Impedance: 50Ω
 - 2. Mechanical:
 - a. Connector: 50Ω type N Female
 - b. Mounting: ceiling mount or securely mounted above ceiling
 - 3. Environmental:
 - a. Temperature: -20°C to $+70^{\circ}\text{C}$
 - b. Plenum rated.
- C. Directional Coverage Antennas
- 1. Electrical
 - a. Frequency band: 698-900 MHz
 - b. VSWR $\leq 1.8:1$
 - c. Gain: ≥ 1.0 dBi
 - d. Maximum Input Power: 25 watts
 - e. Polarization: Vertical
 - f. Vertical Beamwidth: ≥ 65 degrees
 - g. Horizontal Beamwidth: 90 degrees - 180 degrees nominal
 - h. PIM: < -150 dBc
 - i. Impedance: 50Ω
 - 2. Mechanical:
 - a. Connector: 50Ω type N Female
 - b. Mounting: ceiling or wall mount
 - 3. Environmental:
 - a. Temperature: -20°C to $+70^{\circ}\text{C}$
 - b. Plenum rated.
- D. Radiating Cable
- 1. Material:
 - a. Nominal size: $\frac{1}{2}$ " or $\frac{7}{8}$ "
 - b. Outer conductor: Corrugated copper
 - c. Slot Design: milled, two rows.
 - d. Jacket Material: Non-halogenated, fire-retardant polyolefin.
 - e. Dielectric Material: Foam PE
 - f. Inner Conductor Material: Copper wire, copper tube or Copper-clad aluminum wire
 - g. Mounting: Minimum clearance of 2" from walls or other structure, secured at intervals and with hardware pursuant to manufacturer's specifications
 - 2. Electrical

- a. Frequency Range: 30 – 2650 MHz
 - b. Impedance: $50\Omega \pm 1$
 3. Environmental:
 4. Temperature: -20°C to $+80^{\circ}\text{C}$
- E. Foam Dielectric Cable
1. Material:
 - a. Nominal size: $\frac{1}{2}$ " or $\frac{7}{8}$ "
 - b. Outer conductor: Corrugated copper
 - c. Dielectric Material: Foam PE
 - d. Inner Conductor Material: Copper wire, copper tube or Copper-clad aluminum wire
 2. Electrical
 - a. Frequency Range: 30 – 2650 MHz
 - b. Impedance: $50\Omega \pm 1$
 3. Environmental:
 4. Temperature: -20°C to $+80^{\circ}\text{C}$
- F. Splitters, Combiners, Couplers, Taps, Coax Jumpers, and Connectors:
1. Electrical
 - a. Frequency Range: 698 – 2700 MHz
 - b. VSWR $\leq 1.3:1$
 - c. Maximum Input Power: ≥ 50 watts
 - d. PIM: < -150 dBc
 - e. Impedance: 50Ω
 2. Mechanical:
 - a. Connector: 50Ω type N Female
 3. Environmental:
 - a. Temperature: -20°C to $+70^{\circ}\text{C}$
- G. BDA: Bi-Directional Amplifiers utilized on the system must meet the following requirements:
1. Electrical
 - a. Frequency agility: The unit shall have the capability to change operating frequencies within the 700 – 800 MHz Public Safety Band as may be required due to licensing changes of the AHJ or actions of the FCC.
 - b. Alarming Functions: The BDA shall be linked to the building's fire alarm panel and configured to signal an alarm in the event of a failure with the BDA or donor antenna system.
 - c. The BDA shall have received FCC Certification prior to installation.
 - d. The system must be compatible with both analog and digital transmissions.
 - e. Automatic gain and level controls shall be integrated into the BDA with a minimum dynamic range of 60 dB, less any gain reduction setting.

2. Mechanical
 - a. All BDA components shall be housed in a single, NEMA4 cabinet. The cabinet must be waterproof and capable of dissipating all heat without the use of ventilation.
 - b. The BDA cabinet shall be painted fire engine red and display the following labeling in bright yellow letters: "RADIO REPEATER" unless alternate labeling is specified by the AHJ.
 - c. The name and telephone number of the vendor responsible for system maintenance must also be marked on the cabinet.
 - d. If the BDA is not located in the same room as the fire alarm panel, a sign shall be placed at the fire alarm panel with the name and telephone number of the local Fire Department indicating that they shall be notified of any failures that extend past two hours.
 - e. The cabinet shall be securely locked to prevent unauthorized access.
 3. Environmental
 - a. The BDA, as installed in the approved NEMA4 cabinet, shall be designed for operating in temperatures ranging from -22 degrees F to +120 degrees F (-30 degrees C to +50 degrees C).
- H. Power Supplies: At least two (2) independent and reliable power supplies shall be provided, one primary and one secondary.
1. Primary Power: The primary power source shall be supplied from a resolute 20 Ampere branch circuit. The presence of primary power shall be monitored by the BDA monitoring system and provide notification upon loss of primary power.
 2. Secondary Power: The secondary power source shall be capable of operating the in-building radio system for at least 24 hours of 100% system operation. This system shall utilize a dedicated battery system or a self-starting generator with dedicated storage batteries.
 - a. The battery system shall automatically charge in the presence of the external/primary power input.
 - b. The secondary power system shall be engaged automatically upon loss of primary power.
 - c. The secondary power system shall be contained in one NEMA 4 enclosure.
 - d. An alarm shall be configured to signal failure of the battery charging system or if the battery charge falls below 70% of capacity.
 3. Environmental
 - a. The secondary power system, as installed in the approved NEMA4 cabinet, shall be designed for operating in temperatures ranging from -22 degrees F to +120 degrees F (-30 degrees C to +50 degrees C).

PART 3 EXECUTION

3.1 INSTALLATION

- A. System Signal Wires, Power Conductors and Cables

1. Wires and cables shall enter each equipment enclosure, cabinet, or rack in such a manner that all doors or access panels can be opened and closed unobstructed by cables.
2. Routing and Interconnection
 - a. Wires or cables routed between cabinets, racks, and other equipment shall be installed in an approved conduit or cable tray that is secured to the building structure.
3. All cable shall be sweep evaluated for detection of any faults prior to and after installation. Sweep results shall be recorded for future reference.
4. Coaxial cable shall be carefully installed in strict compliance with the manufacturers' recommended procedures with special attention given to pulling tensions, bending radius and proper support.
5. Coaxial antenna cabling, except for radiating cable, shall be installed in its own metallic conduit.
6. All equipment, cable and components shall be installed and connected according to the OEM's specifications to insure correct installation and system performance.
7. Coordinate all roof penetrations with Owner and/or roofing contractor.

3.2 GROUNDING

- A. Ground and bond cable shields and equipment per Manufacturer's requirements and NFPA 70 NEC requirements.
- B. The Donor antenna mast shall be grounded per NFPA 70 NEC requirements. Grounding blocks and surge protection shall be provided for outside coaxial cabling.

3.3 ACCEPTANCE TESTING

- A. An initial set of system Commissioning Tests shall be performed for the Owner prior to final Acceptance Testing with the AHJ. The commissioning tests will include all tests outlined in Part 1.07 C.2., "Submittal Requirements at Project Closeout", "Test Reports".
- B. Tests shall be made using frequencies close to the frequencies used by the appropriate emergency services. If testing is done on the actual frequencies, then this testing must be coordinated with the local Department unit. All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the licensed department frequencies.
- C. Final Acceptance Test Procedures
Acceptance testing shall consist of the following tests, or those tests as may be directed by the AHJ and local County emergency response.
 1. Coverage Testing: For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.4 shall be considered a failed test for a given grid cell. See Part 1.04, DEFINITIONS for descriptions of each DAQ level.
 - a. Each floor of the building shall be divided into 20 grid divisions. Increase to 40 if there is a failure. Critical areas evaluated separately.
 - b. The tests will be conducted by using a calibrated portable two-way radio of the latest brand and model as currently in use by the local Department.
 - c. Small scale drawings (11-inch x 17 inch maximum) of the structure shall be provided by the Contractor for use and documentation of the test results. The

- plans shall show each floor divided into the grids as described above, and the results of any pre-testing. Each grid shall be labeled to indicate the DAQ result from the final acceptance testing.
- d. DAQ tests shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.
 - e. A test location shall be selected near the center of each grid square. Once the test location of a grid area is selected, prospecting for a better spot within the area is permitted only within three feet (3') in any direction of the selected test location.
 - f. The two-way radio will be utilized to transmit voice transmissions to verify communications to and from the outside area covered by the Department's radio system. For each grid location, the DAQ of the transmission shall be determined.
 - g. A maximum of two non-adjacent areas will be allowed to fail the DAQ test.
 - h. In the event that three or more of the grid test locations fail the test, the floor may be re-evaluated by creating a new grid consisting of 80 equal areas and test locations selected within each area. In evaluating the new grid, a maximum of four non-adjacent areas may fail the test. If the system fails the 80-area test, then the system must be revised to meet the coverage requirement.
2. Isolation and Spectrum Analysis Testing:
 - a. Measurement of the isolation between the donor antenna(s) and the system antennas shall be performed utilizing a spectrum analyzer and appropriate signal generator.
 - b. A Spectrum Analysis Report demonstrating only the intended frequencies are being carried on the system.
 - c. Spectrum Analysis Report demonstrating no spurious oscillations or intermodulation products are being produced that would affect other services or system performance.
 3. Other tests as requested by the AHJ.

END OF SECTION 27 53 19

Division 28 – Electronic Safety and Security

SECTION 28 05 28 - PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Surface pathways.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
2. Section 27 05 28 "Pathways for Communications Systems" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets.
- C. Include copies of submittals to be transmitted to the Owner's commissioning entity for review and approval.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. EMT: Comply with ANSI C80.3 and UL 797.
- D. FMC: Comply with UL 1; zinc-coated steel.
- E. 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: compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- F. Joint Compound for 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. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum or general-use installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

2.4 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-B.

- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish.
- C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

- 1. Comply with TIA-569-B.
- 2. 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, ferrous alloy, Type FD, with gasketed cover.

D. Box extensions used to accommodate new building finishes shall be of the same material as recessed box.

E. Metal Floor Boxes:

- 1. Material: Cast or sheet metal.
- 2. Type: Fully adjustable.
- 3. 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.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.

I. Gangable boxes are prohibited.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or 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. Nonmetallic Enclosures: Plastic or fiberglass.
- 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 or 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.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Standard: Comply with SCTE 77.
2. Color of Frame and Cover: Gray.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC or EMT.
3. Underground Conduit: RNC, Type EPC-80-PVC, concrete encased.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC.
 - 6. Damp or Wet Locations: GRC.
 - 7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
 - 8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
 - 9. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway.
 - 10. 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 Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use setscrew fittings. Comply with NEMA FB 2.10.
 - 3. 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 pathways 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, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches of changes in direction.
- E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

- F. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforce at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange pathways to keep a minimum of 1 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

- G. Stub-ups to Above Recessed Ceilings:
 - 1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

- H. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

- I. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

- J. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

- K. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

- L. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.

- M. Surface Pathways:
 - 1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.

- N. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.

- O. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.

- P. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.

- Q. 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 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.
- R. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for luminaires,]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- S. Mount boxes at heights indicated on Drawings according to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

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. 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 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.
 - 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.

5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- C. Install handholes with bottom below frost line, 36" below grade.
- D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY 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 Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

END OF SECTION 28 05 28

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM
PART 1 – GENERAL

1.1 SCOPE

This specification document provides the requirements for the installation, programming, and configuration of a complete digital protocol analog addressable fire alarm system. This system shall include, but not be limited to, system cabinet, power supply, built in Signaling Line Circuit (SLC), 80-character LCD annunciator, six programmable Flexputs, built in dual line Digital Communicator associated peripheral devices, batteries, wiring, conduit and other relevant components and accessories required to furnish a complete and operational Life Safety System.

1.1 MANUFACTURER

The manufacturer of the system equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets the ISO 9000 requirements.

All System components shall be the cataloged products of a single supplier. All products shall be listed by the manufacturer for their intended purpose.

Edwards Systems Technology, Inc., Siemens, or Notifier products constitute the minimum type and quality of equipment to be installed.

All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company and shall be evaluated and cross-listed to ensure that a fully functioning is designed and installed. The system supplied under this specification shall be a microprocessor-based system. The system shall utilize independently addressed microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

Base Bid requirements.

Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed and will accommodate the future requirements and operations of the building owner. All specified operational features must be met without exception.

The authorized representative of the manufacturer of the major equipment shall be responsible for the satisfactory installation of the complete system.

All equipment and components shall be the manufacturer's current model. The materials, appliances, equipment, and devices shall be evaluated and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling system, access control, and smoke control. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

All control panel assemblies and connected field appliances shall be provided by the same system supplier and shall be designed and evaluated to ensure that the system operates as specified. The system shall utilize independently addressed microprocessor-based smoke detectors, heat detectors, as described in this specification.

All equipment and components shall be installed in strict compliance with the manufacturer's recommendations.

The equipment to be supplied will be considered only if it meets all sections of the performance specification. Any deviations of system performance outlined in this specification will only be considered when the following requirements have been met:

1.3 REFERENCES

All work and materials shall conform to all applicable Federal, State, and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state, or local codes, and this specification, it is the bidder's responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent. The bidder shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by the Engineer.

System components proposed in this specification shall be ULI listed to operate together as a system. The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment. The supplier shall be responsible for filing of all documents, paying all fees (including, but not limited to plan checking and permit) and securing all permits, inspections, and approvals. Upon receipt of approved drawings from the authority

having jurisdiction, the supplier shall immediately forward two sets of drawings to the Owner. These drawings shall either be stamped approved or a copy of the letter stating approval shall be included. Evaluated and listed by third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment

1.4 CODES

1.4.1 FIRE

The equipment and installation shall comply with the current provisions of the following codes and standards:

2020 National Electric code

NFPA 70 – 2020 North Carolina Electrical Code

NFPA 72 – 2013 National Fire Alarm Code®

NFPA 90A – 2012 Air Conditioning Systems

NFPA 101- 2012 Life Safety Code®

UL 864 - Control Units for Fire Protective Signaling Systems.

UL 268 - Smoke Detectors for Fire Protective Signaling Systems.

UL 268A - Smoke Detectors for Duct Applications.

UL 521 - Heat Detectors for Fire Protective Signaling Systems.

UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.

UL 464 - Audible Signaling Appliances.

UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems

UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.

UL 1971 - Signaling Devices for the Hearing-Impaired.

UL 1481 - Power Supplies for Fire Protective Signaling Systems.

Factory Mutual (FM) approval

Federal Codes and Regulations

Americans with Disabilities Act (ADA)

International Standards Organization (ISO)

ISO-9000

ISO-9001

1.01.a.1

The Engineer of Record is the Authority Having Jurisdiction for the fire alarm system during construction. It is the responsibility of the fire alarm contractor to notify the State Fire Alarm Inspector at the State Construction Office to schedule the required final inspection.

1.5 SYSTEM DESCRIPTION

1.5.1 GENERAL

The Contractor shall furnish all labor, services, and materials necessary to furnish and install a complete, functional fire alarm system (System). The System shall comply in respects with all pertinent codes, rules, regulations and laws of the Authority, and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, manufacturer's recommendations, and Underwriters Laboratories Inc. (ULI) listings.

It is further intended that upon completion of this work, the Owner be provided with:

Complete information and drawings describing and depicting the entire system(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system(s) at a future date.

Complete documentation of system(s) testing.

Certification that the entire system(s) has/have been inspected and evaluated, is/are installed entirely in accordance with the applicable codes, standards, manufacturer's recommendations and ULI listings, and is/are in proper working order. The "Record of Completion" for the fire alarm system should be from NFPA 72, 2013 edition for compliance with the 2018 NC State Building Code.

1.5.2 DESCRIPTION 24VDC NACS

Provide and install a new fire detection and alarm system that shall consist of:

Fire Alarm Control Panel located as shown on the drawings.

LCD remote annunciator(s) located as shown on the drawings.

Manual pull stations are located as shown in the drawings.

Area smoke detectors are located as shown in drawings.

Area heat detectors are located as shown in drawings.

Duct smoke detectors are located as shown in the drawings.

Sprinkler system waterflow(s) and valve supervisory switch(s) located as shown in the drawings.

Interface with suppression system(s) as shown on the drawings.

Provide audible notification appliances located as shown on the drawings.

Provide synchronized visual notification appliances located as shown on the drawings.

Provide magnetic door holders, located as shown in drawings.

Provide elevator recall functions for primary and alternate floors and elevator power shunt trip activation.

Provide connection to a central station. The owner shall arrange for two dedicated phone lines to be terminated as directed by the installing contractor.

1.5.2 SEQUENCE OF OPERATIONS

1.5.2.1 GENERAL 24 VDC NACS

The alarm activation of any area smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:

The internal audible device shall sound at the control panel and remote annunciator.

The LCD display shall indicate all applicable information associated with the alarm condition including device type, device location and time/date.

All system activity/events shall be documented in system history and on the system printer.

Any remote or local annunciator LCD/LEDs associated with the alarm shall be illuminated.

Activate notification audible appliances throughout the building.

Activate visual strobes notification appliances throughout the building. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the "Alarm Silence" is pressed.

Transmit an alarm signal to the central station.

All automatic events programmed to the alarm point shall be executed and the associated outputs activated.

All stairwell/exit doors shall unlock throughout the building.

All self-closing fire/smoke doors held open shall be released.

1.5.2.2 DUCT SMOKE OPERATION

The Alarm activation of any duct smoke detector, the following functions shall automatically occur:

The internal audible device shall sound at the control panel and remote annunciator.

The LCD display shall indicate all applicable information associated with the alarm condition including device type, device location and time/date.

All system activity/events shall be recorded on the system printer and system history file.

Any remote or local annunciator LEDs associated with the alarm shall be illuminated.

Transmit an alarm signal to the central station.

Shutdown the local air handling unit.

All automatic events programmed to the alarm point shall be executed and the associated outputs activated.

Activate the notification audio/visual appliances throughout the building.

AHU Shutdown Defeat Switch for manual operation of the HVAC system in emergency conditions will be provided. This switch should be in an accessible location near the Fire Alarm Control Panel or near the Remote Annunciator Panel. In some cases, it can be a built-in security function in the Fire Alarm Panel.

1.5.2.3 SUPERVISORY OPERATION

Upon supervisory activation of any sprinkler valve supervisory switch, the following functions shall automatically occur:

The internal audible device shall sound at the control panel and remote annunciator.

The LCD display shall indicate all applicable information associated with the supervisory condition including device type, device location and time/date.

Any remote or local annunciator LCD/LEDs associated with the supervisory activation shall be illuminated.

Transmit a supervisory signal to the central station.

1.5.2.4 TROUBLE OPERATION

Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:

The internal audible device shall sound at the control panel and remote annunciator.

The LCD display shall indicate all applicable information associated with the trouble condition including device type, device location and time/date.

All system activity/events shall be documented on the system printer and system history file.

Any remote or local annunciator LCD/LEDs associated with the trouble zone shall be illuminated.

Transmit a trouble signal to the central station.

1.5.2.5 MONITOR ACTIVATION

Upon activation of any device connected to a monitor circuit, the following functions shall automatically occur:

The monitor LED will light, and pre-programmed functions will activate.

1.5.3 SYSTEM CONFIGURATION

1.5.3.1 GENERAL

All Life Safety System equipment shall be arranged and programmed to provide a system for the early detection of fire, the notification of building occupants, the automatic summoning of the local fire department, the override of the HVAC system operation, and the activation of other auxiliary systems to inhibit the spread of smoke and fire, and to facilitate the safe evacuation of building occupants.

The System shall utilize independently addressed smoke detectors, heat detectors and input/output modules as described elsewhere in this specification.

Addressable interface modules (used to monitor all contact type initiating devices) must be located in conditioned space, unless they are evaluated, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location. With AHJ approval they may be permitted to serve as many as 3 sprinkler system valve supervisory switches, or 6 heat detectors, in a single space.

There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will not be permitted. Permanent wire markers shall be used to identify all connections at the FACU and other control equipment, at power supplies, and in terminal cabinets.

Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from

ground, and terminated at the FACU. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.

EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.

EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

CAUTION: The previous requirement for 3/4" conduit no longer exists but cable size and the requirement to maintain a Class "A" loop on all Signaling Line Circuits frequently cause conduit fill to exceed specified maximums if the 1/2" size is used. Therefore, 3/4" raceway is still strongly recommended.

POWER SUPPLY

The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 4.5A continuous for notification appliance circuits.

All outputs shall be power limited. The battery shall be sized to support the system for 60 hours of supervisory and trouble signal current plus general alarm for 15minutes. Auxiliary power supplies shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 6.4 continuous for notification appliance circuits. The power supply shall be capable of providing 8A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 60 hours of supervisory and trouble signal current plus general alarm for 15 minutes. All supervision of the auxiliary supply shall be transmitted via addressable analog loop without additional equipment.

On AC Input: A feed-through (not a shunt-type) branch circuit transient arrestor such as the EFI HWM-120, Leviton OEM-120EFI, Northern Technologies DMK-B, Transtector ACP100BWN3, or any equivalent UL Listed device submitted to and approved by the electrical design engineer. Install suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. The wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped.

On DC Circuits Extending Outside Building: Adjacent to the FACU, and also near point of entry to outlying building, provide "pi"-type filter on each leg, consisting of a primary arrestor, series impedance, and a fast-acting secondary arrestor that clamps at 30v-40v. Some acceptable models: Innovative Technology D2S33-2ML, Transtector TSP8601, Ditek DTKxLVL series, Citel America B280-24V, and Northern Technologies DLP-42. Submit specifications on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration. Devices using only MOV active elements are not acceptable.

1.5.3.3 DISPLAY

The display module shall be of membrane style construction with a 4 line by 20-character Liquid Crystal Display. The LCD shall use super-twist technology and backlighting for high contrast visual clarity. In the normal mode display the time, the total number of active events and the total number of disabled points. In the alarm mode display the total number of events and the type of event on display. Reserve 40 characters of display space for user custom messages. The module shall have visual indicators for the following common control functions; AC Power, alarm, supervisory, monitor, trouble, disable, ground fault, CPU fail, and test. There shall be common control keys and visual indicators for; reset, alarm silence, trouble silence, drill, and one custom programmable key/indicator. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicator that lights when an event of its type is active. Allow the first event of the highest priority to capture the LCD for display so that arriving fire fighters can view the first alarm event "hands free". Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.

1.5.3.4 INITIATING DEVICE CIRCUITS

The Initiating device circuits (IDC) used to monitor manual fire alarm stations, smoke, and heat detectors, waterflow switches, valve supervisory switches, fire pump functions, and air pressure supervisory switches shall be Class A (Style "D" or "E")

1.5.3.5 24 VDC NOTIFICATION APPLIANCE CIRCUITS

24 VDC Notification appliance circuits (NAC) shall be Class B (NFPA 72 Style "Y"). All notification appliance circuits shall have a minimum circuit output rating of 2 amp @ 24 vdc. The notification circuits shall be power limited. Non-power limited circuits are not acceptable.

1.5.3.6 SIGNALING LINE CIRCUITS

The signaling line circuit shall communicate from a panel/node to analog/addressable detectors, input modules, output modules, isolation modules and notification appliance circuits.

Each signaling circuit connected to addressable/analog devices shall provide a minimum of 20 spare addresses.

When a signaling line circuit covers more than one fire/smoke compartments, a wire-to-wire short shall not affect the operation of the circuit from the other fire/smoke compartments.

The signaling line circuit (SLC) connecting panels and annunciators shall be Class A (style 7).

The signaling line circuit connecting to addressable/analog devices including detectors, monitor modules, control modules, isolation modules, and notification circuit modules shall be Class A (style 6) with no t-taps.

Isolation modules shall be added in the following locations.

- 1.01.b In or immediately adjacent to the FACU, at each end of the addressable loop. These two isolators must be in the same room as the FACU and within 15 feet.
- 1.01.c After each 20 initiating devices and control points on the addressable loop, or a lesser number

where recommended by the manufacturer.

- 1.01.d Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling) and shown on as-built drawings.
- 1.01.e Isolation modules are required for each floor supplied by a common initiating device loop or signaling loop.

1.5.3.7 DACT

The panel shall have a dialer (alarm communicator transmitter (DACT)) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station (CMS). The DACT shall support dual telephones lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program using a touch tone phone and password.

1.6 SUBMITTALS

1.6.1 PROJECT SUBMITTAL

The contractor shall purchase no equipment for the system specified herein until the owner has approved the project submittals in their entirety and has returned them to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The contractor shall submit three (3) complete sets of documentation within 30 calendar days after award of purchase order.

Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition, the contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

All drawings and diagrams shall include the Contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparers and reviewers' initials.

Data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Architect/Engineer.

A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:

Control panel wiring and interconnection schematics.

Complete point to point wiring diagrams.

Complete floor plan drawing locating all system devices and 1/4' = 1'-0 scale plan and elevation of all equipment in the Fire Command Station. Including showing the placement of each individual item of fire alarm equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.

Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.

Complete system bill of material.

All drawings shall be reviewed and signed off by an individual having a minimum of a NICET certification in fire protection engineering technology, subfield of fire alarm systems.

A sample of each smoke detector, intelligent modules, horn, and strobes shall be provided to the contractor for their familiarization.

1.6.2 QUALITY ASSURANCE/CONTROL SUBMITTALS

A. INSTALLER'S CERTIFICATION

The engineered systems distributor must be licensed in the state of project location and have been incorporated in the business in that state for a minimum of 5 years.

Submit a copy of the contractors training certification issued by the manufacturer of the Life Safety System.

The technicians are required to be trained and individually certified by the manufacturer for the FACP model to be installed. This training and certification must have occurred within the most recent 24 months. Copies of the certifications must be part of the contractor's submittal to the engineer, prior to installation. This submittal cannot be approved without this information.

Systems are to be provided with a separate and independent source of secondary power. All systems that report to a Central or Remote Supervising Station shall have a minimum of 60 hours secondary power capacity, plus 5/15 minutes of full alarm load. Proprietary and other systems require 60 hours capacity plus 5/15 minutes alarm load. See NFPA 72.

EXCEPTION #1: For emergency voice/alarm systems, use 15 minutes for alarm load.

EXCEPTION #2: If single, automatic starting generator is provided, use 60 hours for battery endurance, plus the appropriate (5 or 15 minutes) alarm load. See NFPA 72, 2013 edition.

NOTE: Most campus alarm supervising stations are normally classified as "Proprietary" systems.

Include a copy of system battery sizing calculations with the shop drawing submittal to the engineer. Use manufacturer's battery discharge curve to determine expected battery voltage after 60 hours of providing standby power. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at EOL, based on conductor resistance per manufacturer's data sheet or 2020 NC Electrical Code, Table 8. Remember to double the ohms per foot since two conductors are required to power the circuit. Also, add any inherent voltage drop caused by the system's power supply.

The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24-volt system, this limits the voltage drop from the battery to the EOL to 3 volts). Determine the "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used.

All of these calculations must be placed on a dedicated sheet of as-built drawings, for future refer

ence by fire alarm service technicians. NAC voltage drop is to be verified during system tests.

NOTE: Free software for the above calculations is available at: <http://www.alarmsaf.com/powercad.html>

CONTRACTOR'S SHOP DRAWINGS, REVIEW, CODE COMPLIANCE, COMPLETENESS OF SYSTEM

The fire alarm contractor shall submit complete Shop Drawings to the engineer for review, prior to performing any work. These shall clearly demonstrate compliance with the engineer's plans and specifications, which have a System Response Matrix showing the fire alarm system's actions (outputs) required for each type of alarm, supervisory, and trouble signal. NOTE: Any non-compliant features must be fully described. Engineer's approval (with or without corrections) of contractor's Shop Drawings, samples, cut sheets, etc., is for general conformance with the contract documents and design concept. It shall not relieve the contractor of responsibility for full compliance with the project plans and specifications, EXCEPT for any specific non-compliant features for which the engineer gives written authorization.

The fire alarm system shall comply with applicable provisions of the NC Building Code (available for sale at NCDol), and the National Fire Alarm Code (NFPA 72, 2013 edition).

The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.

Complete calculations shall be provided which show the electrical load on the following system components:

Each system power supply, including standalone booster supplies.

Each standby power supply (batteries).

Each notification appliance circuit.

Each auxiliary control circuit draws power from any system power supply.

1.6.2 CLOSEOUT SUBMITTAL

Two (2) copies of the following documents shall be delivered to the building owner's representative at the time of system acceptance. The close out submittals shall include:

Project specific operating manuals covering the installed Life Safety System. A generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.

As-Built drawings consisting of a scaled plan of each building showing the placement of each individual item of the Life Safety System equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and automatically graphically documented by the system.

Provide all drawings shall be provided in standard .DXF format. A vellum plot of each sheet shall also be provided.

The application program listing for the system as installed at the time of acceptance by the building owner and/or local AHJ (disk, hard copy printout, and all required passwords).

Provide the name, address, and telephone number of the authorized factory representative.

A filled-out Record of Completion similar to NFPA 72, 2013 edition, figure 1-6.2.1.

The fire alarm system contractor shall provide the engineer two bound copies of the following technical information, for transmittal to the owner: (1) As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment, (2) Manufacturer's detailed maintenance requirements, (3) Technical literature on all control equipment, isolation modules, power supplies, alarm/supervisory signal initiating devices, alarm notification appliances, relays, etc., (4)

1.7 QUALITY ASSURANCE

1.7.1 QUALIFICATION OF CONTRACTORS

1.7.1.1 QUALIFICATIONS OF CONTRACTOR

The contractor shall have successfully installed similar system fire detection, signaling control components on a previous project of comparable size and complexity. The owner reserves the right to reject any control components for which evidence of a successful prior installation performed by the contractor cannot be provided.

The contractor shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and remote-control equipment. Qualified and approved representatives of the system manufacturer shall produce all panel and equipment drawings and submittals, operating manuals. The contractor is responsible for retaining qualified and approved representative(s) of those system manufacturers specified for detailed system design and documentation, coordination of system installation requirements, and final system testing and commissioning in accordance with these specifications.

All connections to the FACU and the system's programming shall be done only by the manufacturer, or by an authorized distributor that stocks a full complement of spare parts for the system. The technicians who do this are required to be trained and individually certified by the manufacturer, for the FACU model/series being installed. This training and certification must have occurred within the most recent 24 months, except that a NICET Level III certification will extend this to 36 months. Copies of the certifications must be part of the Shop Drawing submittal to the engineer, prior to installation. The submittal cannot be approved without this info.

The technician who makes final connections and programs the FACU is legally the "installer" even though most field connections to system devices and appliances are normally made by electrical contractor personnel. The responsibility for assuring a proper installation overall rest with this individual. In addition to doing the final hookups and activating the system, this individual is expected to check enough field connections to assure a proper job was done there. The absence of system "trouble" signals is not a sufficient measure of the field wiring, which could have "T" taps, the wrong type of wire, improper terminations, ground (drain wire) issues, etc.

NOTE: This means the electrical contractor is not permitted to apply power to the FACU or any system power supplies, or to make any connections to them. However, the electrical contractor is

responsible for installing and making field connections to initiating devices, notification appliances, control relays, and other components.

1.8 WARRANTY AND MAINTENANCE

1.8.1 WARRANTY

The contractor shall warranty all materials, installation, and workmanship for one (1) year from date of acceptance, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.

The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.

1.8.2 SPARE PARTS

The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. If FACU also serves auxiliary buildings (e.g., storage, boiler/chiller), calculate as if one building. Increase decimal quantities to the next higher whole number:

- Fuses (If used).....2 of each size in system.
- Manual Fire Alarm Boxes.....2% of installed quantity
- Addressable Control Relays.....4% of installed quantity
- Indoor Horns/Speakers with Strobes Lights.....4% of installed quantity
- Indoor Strobe-only Notification Appliances.....4% of installed quantity
- Monitor Modules (Addressable Interface).....4% of installed quantity.
- Isolation Modules / Isolation Bases.....4% of installed quantity
- Addressable, Electronic Heat Detectors.....4% of installed quantity
- Spot-Type Smoke Detectors / Sounder Bases.....6% of installed quantity

No spares are required for projected beam, air sampling, or duct smoke detectors.

1.9 TRAINING

1.9.1 TRAINING

The System Supplier shall schedule and present a minimum of 2 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.

The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURER

2.1.1 MANUFACTURER

Acceptable fire alarm system manufacturers include:
Edwards Systems Technology, Inc., Siemens, or Notifier.

All equipment and components shall be the manufacturer's current model. The materials, appliances, equipment, and devices shall be evaluated and listed by a nationally recognized approval agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

The contractor shall provide, from the acceptable manufacturer's current product lines, equipment, and components, which comply with the requirements of these specifications. Equipment or components which do not provide the performance and features required by these specifications are not acceptable, regardless of manufacturer.

2.2 PANEL COMPONENTS & FUNCTIONS

2.2.1 GENERAL

The control panel shall be a multi-processor-based system designed specifically for fire and releasing system applications. The control panel shall be listed and approved for the application standard(s) as listed under the General section.

The control panel shall include all required hardware, software, and system programming to provide a complete and operational system. The control panel shall assure that life safety takes precedence among all panel activities.

The control panel shall include the following capacities:

Support up to 380 analog/addressable points per panel (1,900 total with 5 networked panels)

Support up to 5 fully supervised network remote annunciators.

Support a DACT (dialer) for off premise notification.

Support up to 576 chronological events in history.

The control panel shall include the following features:

Provide auto programming and electronic addressing and mapping of analog/addressable devices.

Provide an operator interface display that shall include functions required for annunciation, command, and control system functions.

Provide a discreet system control switch provided for reset, alarm silence, local silence, drill switch, up/down switches, status switch, program switch, enable and disable switches, activate, and restore switches, reports switch and test switch.

Provide system reports that provide sensitivity and history details.

Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords; and auto program, enable mapping, restart the system, and clear control pan

el event history file.

Provide an authorized operator to perform test functions within the installed system.

Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure.

2.2.2 ANNUNCIATION

The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. The manufacturer's standard control switches shall be acceptable if they provide the required operation, including performance, supervision, and position indication. If the manufacturers' standard switches do not comply with these requirements, fabrication of custom manual controls acceptable to the owner is required.

Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device.

The annunciator shall contain the following system status indicators:

80-character Backlit Liquid Crystal Display.

System Power Indicator - green LED.

System Common Alarm - red LED.

System Common Trouble - yellow LED.

System Common Supervisory - yellow LED.

System Common Monitor - yellow LED.

System Ground Fault - yellow LED.

System CPU Fault - yellow LED.

System Disabled - yellow LED.

System Test Point(s) - yellow LED.

System Reset Switch with Integral yellow LED.

System Alarm Silence Switch with Integral yellow LED.

System Local Silence Switch with Integral yellow LED.

System Drill Switch with Integral yellow LED

System Message Queue Scroll Switches.

Additional buttons as required to provide system control and operator functions.

2.2.3 POWER SUPPLY

Each system's power supply shall be a minimum of 6 amps @ 24 vdc.

Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any alarm, trouble, or operator acknowledgment signals.

Each system's power supply shall be individually annunciated and shall identify the inoperable power supply in the event of a trouble condition.

All standby batteries shall be continuously monitored by the system. Low battery and disconnection of battery power supply conditions shall immediately annunciate as a trouble signal, identifying the deficient batteries.

All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of Section 1-5.2 of NFPA 72 - 2013. The AC power circuit shall be installed in conduit raceway. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside each control panel.

2.2.4 DISPLAY

The system shall allow message routing to be configured to any or all annunciators.

All system printer port shall be configurable to output any combination of alarm, supervisory, trou

ble, or monitor, event messages.

Each LCD display on each annunciator shall be configurable to display the status of any combination of alarm, supervisory, trouble, or monitor, event messages.

Clear distinction shall be provided between alarm, supervisory, trouble, and monitor status messages.

The system shall provide the ability to retrieve data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The uploaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.

A standby power supply shall automatically supply electrical energy to the system upon primary power supply failure.

DIALER – DACT

The system shall provide an off-premises Digital Alarm Communications Transmitter (DACT) capable of transmitting system alarm, trouble, and supervisory events to a central monitoring station (CMS). The DACT shall support dual telephone lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program the DACT using a touch tone phone and password.

2.2.6 REPORTS

The system shall provide the operator with system reports that give detailed chronological description of the last 576 system events. The system shall provide a report that gives a listing of the sensitivity and environmental compensation usage of all of the detectors on the system, or specified analog/addressable circuit.

The system report shall also include facility name, compiled date, compiler revision, project revision and report date. The system shall output these reports via the main LCD, and reports shall be capable of being printed on the system printer.

2.3 FIELD-MOUNTED SYSTEM COMPONENTS

2.3.1 INITIATING DEVICES

Note: Initiating Devices shall be wired Class A NFPA Style D.

2.3.1.1 SMOKE DETECTORS & ACCESSORIES

2.3.1.1.1 ANALOG ADDRESSABLE SMOKE GENERAL

Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive, or least sensitive.

An alternate alarm sensitivity level shall be provided for each detector, which can be set to any of the five (5) sensitivity settings manually or automatically using a time-of-day event.

The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signaling that 80% to 99% compensation has been used. The detector shall provide a dirty fault signal that 100% compensation has been used.

The system shall allow for changing detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. The system shall display an off-normal condition until the proper detector type has been installed or a change in the application program profile has been made.

2.3.1.1.2 SMOKE DETECTOR - PHOTOELECTRIC

Provide analog/addressable photoelectric smoke detectors at the locations shown on the drawings.

The system shall have the ability to set the sensitivity and alarm verification of each of the individ

ual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting alarm signals as well as normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value.

2.3.1.1.2.b SMOKE DETECTOR – OPTICAL BEAM

Provide analog/addressable optical beam smoke detectors at the locations shown on the drawings. The system shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting alarm signals as well as normal, trouble and need cleaning information.

2.3.1.1.3 END-OF-LINE RESISTOR (EOL)

1. Fire Alarm System notification circuits an end-of-line (EOL) resistor should be located as follows:
 - a. In a location that is accessible to fire alarm maintenance personnel.
 - b. In an area where maintenance or testing at the EOL resistor location will not be disruptive to the normal use of the facility
 - c. In an area that is not easily accessible to the normal building occupants (objective is to avoid accidental or malicious damage by building occupants)
 - d. In an area that is no higher 9 ft. or lower than 7 ft. from the floor level.
 - e. Not located in a stairway or bathroom location

2.3.1.1.4 DUCT DETECTOR MOUNTING PLATE

Where smoke detectors are directly inserted into a low velocity ducts 3 ft (0.91m) high x 3 ft

(0.91m) wide, ceiling plenums, or raised floors, provide factory supplied mounting plate assemblies to facilitate mounting the detectors. The mounting plate shall be code gauge steel with corrosion resistant red enamel finish. The detector mounting plate shall support an analog/addressable detector along with a standard, relay, or isolator detector-mounting base.

2.3.1.1.5 DUCT DETECTOR HOUSING

Provide smoke detector duct housing assemblies to mount an analog/addressable detector along with a standard, relay or isolator detector mounting base. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.

2.3.1.2 HEAT DETECTORS

2.3.1.2.1 FIXED TEMPERATURE-ROR HEAT DETECTOR

Provide analog/addressable combination fixed temperature / rate-of-rise detectors at the locations shown on the drawings. The heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate of rise alarm point of 15°F(9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

A supervised "AHU Shutdown Defeat" switch must be provided in/adjacent to the FACU or as a key-operated function in the Remote Annunciator (if provided). If the RA option is utilized, provide an informative engraved label at the FACU about this function. The switch must cause a system "trouble" indication when it is placed in the off-normal ("Shutdown Defeated") position.

2.3.1.3 DETECTOR BASES

2.3.1.3.1 DETECTOR BASE - STANDARD

Provide standard detector mounting bases suitable for mounting on either North American 1-gang, 3½ or 4-inch octagon box and 4-inch square box, or European BESA or 1-gang box. The base must be a plug-in type of detector with a separate base not a mounting ring. The base will have integral terminal strips for circuit connections rather than wire pigtails.

2.3.1.4 MANUAL STATIONS

2.3.1.4.1 MANUAL STATION - DOUBLE ACTION SINGLE STAGE

Provide analog/addressable double action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers.

2.3.2 NOTIFICATION APPLIANCES

2.3.2.1 GENERAL

2.3.2.1.1 GENERAL (SIGNALS)

All appliances which are supplied for the requirements of this specification shall be UL Listed for Fire Protective Service and shall be capable of providing the "equivalent facilitation" which is allowed under the Americans with Disabilities Act Accessibilities Guidelines (ADA(AG)) and shall be UL 1971 Listed.

All appliances shall be of the same manufacturer as the fire alarm control panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturer's instructions.

Any appliances that do not meet the above requirements and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100%

compatible with each other for the purpose intended. All strobes shall be provided with lens markings oriented for wall mounting.

All notification appliances shall be red unless noted otherwise on the drawings.

2.3.2.2 HORNS

2.3.2.2.1 LOW PROFILE HORNS

Provide low profile wall mount horns at the locations shown on the drawings. The horn shall provide an 84 dBA sound output at 10 ft. when measured in reverberation room per UL-464. The horn shall have a three-beat temporal output. In and out screw terminals shall be provided for wiring. The horn shall mount in a North American 1-gang box.

2.3.2.3 HORN-STROBES

2.3.2.3.1 LOW PROFILE HORN-STROBES

Provide low profile wall mount horn/strobes at the locations shown on the drawings. The horn/strobe shall provide an audible output of 84 dBA at 10 ft. when measured in reverberation room per UL-464. Strobes provide synchronized flash outputs. The horn shall have a three-beat temporal output. In and out screw terminals shall be provided for wiring. Low profile horn/strobes shall mount in a North American 1-gang box.

2.3.2.4 STROBES

2.3.2.4.1 LOW PROFILE STROBES

Provide low profile wall mounted strobes at the locations shown on the drawings. In and out screw terminals shall be provided for wiring. Strobes provide synchronized flash outputs. Low profile strobes shall mount in a North American 1-gang box.

2.3.3 INITIATION & CONTROL MODULES

2.3.3.1 RELAY MODULE

Provide addressable control relay circuit modules at the locations shown on the drawings. The module shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware.

2.3.3.2 NOTIFICATION APPLIANCE CIRCUITS

Provide addressable notification appliance circuit modules at the locations shown on the drawings. The module shall provide one (1) supervised Class B notification circuit. The module shall provide polarized audible / visual selection for 24Vdc @ 2amps, audio outputs at 25Vrms @ 50 watts or 70 Vrms @ 35 watts.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 GENERAL

All equipment shall be attached to walls and ceiling/floor assemblies and shall be mounted firmly in place. Detectors shall not be supported solely by suspended ceilings. Fasteners and supports shall be sized to support the required load.

Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACU: (Addressable Loop # -- Device #) Show on the as-built plans, and also permanently mount on each detector's base so that it is readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing.

Notification Appliance Circuit booster ("ADA") power supplies must be individually monitored by the FACU and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non-conditioned space. NOTE: A 24vdc power circuit serving addressable control relays must also be monitored for integrity.

Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A diskette or CD copy of this data shall be submitted to the engineer for transmission to the owner on the

day the system is commissioned.

Addressable devices are not to be installed in conditioned spaces.

To minimize wiring fault impact, isolation modules shall be provided in all of the locations listed below. If ceiling height ≤ 10 feet, isolator base type initiating devices are permitted to be used to satisfy any or all of the following:

In or immediately adjacent to the FACU, at each end of the addressable loop. These two isolators must be in the same room as the FACU and within 15 feet. After each 25 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer. (Check instructions.)

For loops with less than 25 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACU).

Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.

For loops covering more than one floor, install an isolator at terminal cabinet on each floor (with additional isolator[s] on any floor with over 25 addresses).

Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling) and shown on as-built drawings.

When programming the system, activate the automatic drift compensation feature for all spot-type smoke detectors. Systems with alarm verification are not to have this feature activated without written direction from the owner's representative or the AHJ. Alarm verification must not be used with multi-sensor/multi-criteria detectors under any circumstances, as inadequate system response may result.

3.1.2 CONDUCTORS

The requirement of this section apply to all system conductors, including all signaling line, initiating device, notification appliance, auxiliary function, remote signaling, AC and DC power and grounding/shield drain circuits, and any other wiring installed by the Contractor pursuant to the requirements of these Specifications.

All circuits shall be rated power limited in accordance with NEC Article 760.

Installed in conduit or enclosed raceway.

All new system conductors shall be of the type(s) specified herein.

All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper.

All signaling line circuits, including all addressable initiating device circuits shall be 18 AWG minimum multi-conductor jacketed twisted cable or twisted shielded or as per manufacturer's requirements.

All non-addressable initiating device circuits, 24 VDC auxiliary function circuits shall be stranded 14 AWG copper, THHN/THWN conductors minimum or per manufacturer's requirements.

All notification appliance circuit conductors shall be solid copper or bunch tinned (bonded) stranded copper. Where stranded conductors are utilized, a maximum of 19 strands shall be permitted for No. 14 and larger conductors.

All audible notification appliance circuits shall be 14 AWG minimum twisted pairs or twisted pairs shielded or per manufacturer's requirements.

All visual notification appliance circuits shall be 14 AWG minimum THHN or twisted pairs or twisted shielded pairs or per manufacturer's requirements.

All circuits in the system shall be wired with AWG 14, stranded copper, THHN/THWN conductors, installed in conduit. Color code as shown below throughout the system, without color change in any wire run:

Alarm notification Appliance Circuits (horns/strobes).....Blue (+)/Black (-)
 Separate 24vdc Operating Power (for equipment).....Yellow (+)/Brown (-)
 Door Control Circuits (magnet power, if from system).....Orange
 Circuits from ZAM's to Monitored Devices (AWG 14/16).....Violet (+)/Grey (-)

3.1.3 CONDUCTORS AND RACEWAY

Except as otherwise required by Code and/or these Specifications, the installation of all system circuits shall conform to the requirements of Article 760 and raceway installation to the applicable sections of Chapter 3 of NFPA 70 - 2011, North Carolina Electrical Code. Fire alarm circuit wiring shall include all circuits described in Section 760-1 including Fine Print Note No. 1 (FPN No. 1), and as defined by the manufacturer's UL listing.

The entire system shall be installed in a skillful manner in accordance with approved manufacturer's installation manuals, shop drawings and wiring diagrams. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for the complete installation. All wiring shall be of the type required by the NEC and approved by local authorities having jurisdiction for the purpose.

Any shorts, opens, or grounds found on new or existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

The contractor shall neatly tie-wrap all field-wiring conductors in the gutter spaces of the control panels and secure the wiring away from all circuit boards and control equipment components. All field-wiring circuits shall be neatly and legibly labeled on the control panel. No wiring except home runs from life safety system circuits and system power supply circuits shall be permitted in the control panel enclosures. No wiring splices shall be permitted in a control panel enclosure.

All penetration of floor slabs and firewalls shall be fire stopped in accordance with all local fire codes.

3.1.4 CONDUIT RACEWAY

All systems and system components listed to UL864 Control Units for Fire Protective Signaling Systems may be installed within a common conduit raceway system, in accordance with the manufacture's recommendations. System(s) or system components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.

The requirements of this section apply to all system conduits, raceways, electrical enclosures, junction boxes, pull boxes and device back boxes.

All system conduits shall be of the sizes and types specified.

All system conduits shall be EMT, 3/4 -inch minimum, except for flexible metallic conduit used for whips to devices only, maximum length 6 feet, 3/4-inch diameter, minimum.

All system conduits, which are installed in areas which may be subject to physical damage or weather, shall be IMC or rigid steel, 3/4 -inch minimum.

Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for system conduits shall not exceed 40%.

Provide all new conduit raceway and conduit riser.

All fire alarm conduit systems shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with existing building systems, facilities, or equipment, and to facilitate service and minimize maintenance.

All conduits, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls. Conduits shall not be attached to existing conduit, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, notification, or auxiliary function devices.

All system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures, and device back boxes shall be readily accessible for inspection, testing, service, and maintenance.

3.2 FIELD QUALITY CONTROL

3.2.1 TEST & INSPECTION

All intelligent analog addressable devices shall be evaluated for current address, sensitivity, and user defined message.

All wiring shall be evaluated for continuity, shorts, and grounds before the system is activated.

All test equipment, instruments, tools, and labor required to conduct the tests shall be made available.

ble by the installing contractor.

The system including all its sequence of operations shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made, and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives, and the fire inspector.

At the final test and inspection, a factory trained representative of the system manufacturer shall demonstrate that the system functions properly in accordance with these specifications. The representative shall provide technical supervision and participate in all of the testing for the system.

All fire alarm testing shall be in accordance with National Fire Alarm Code, NFPA 72 - 2013, Chapter 7.

A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally evaluated by a manufacturer's certified representative, and that the system is in proper working order.

Perform the following field tests and inspections and prepare test reports:

- 1.01.f Print a complete System Status and Programming Report that includes the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector.
- 1.01.g The manufacturer or authorized distributor must 100% evaluate all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the System Status and Programming Report.
- 1.01.h Upon completion of the installation and its programming, the fire alarm technician shall evaluate every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including elevator capture and the control of HVAC systems, door locks, fire, or smoke doors/dampers/shutters, etc. The Engineer must be notified in advance of these 100% tests, to permit witnessing them if desired.
- 1.01.i The Contractor must fill out and submit the following documentation to the Owner, through the ADW-23014

Engineer, prior to the AHJ's system acceptance inspection:

- 1.01.i.1 The NFPA 72 "Record of Completion" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code-required 100% test was performed. If a representative of the AHJ, Owner, or Engineer witnesses the tests, they sign the last line of the form to signify that fact only (annotating the form as needed).
- 1.01.i.2 The System Status and Programming Report. This must be generated on the day of the system acceptance inspection.
- 1.01.i.3 After completion of the 100% system test and submission of documentation, the Contractor is to request the Engineer to set up an inspection. The system must operate for at least two days prior to this inspection.
- 1.01.i.4 The fire alarm system will be inspected, with portions of it functionally evaluated. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally evaluating the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system will be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has professionally installed the system and performed the 100% operational test as required by NFPA 72. The Contractor is responsible for providing two-way radios, ladders, and other materials needed for evaluating the system, including a suitable smoke source.
- 1.01.j Basic operating instructions shall be framed and permanently mounted at the FACP. In addition, the NFPA 72 "Record of Completion" must either be kept at/in the FACP, or its location shall be permanently indicated there by engraved label.
- 1.01.j Provide an engraved label inside the FACP identifying its 120-volt AC power source, as follows: panelboard location, panelboard identification, and branch circuit number.
- 101.k The Contractor is to include the State Construction Office electrical inspector in 7-day advance notification of testing and require notification from the State Construction Office electrical inspector for the scheduled date of the Final Inspection.

END OF SECTION 28 31 11

Division 31 – Earthwork

SECTION 31 02 00 - GENERAL SITEWORK REQUIREMENTS

PART 1 - GENERAL

1.1 SITEWORK LAYOUT

- A. Monuments and Benchmarks
 - 1. Maintain all monuments, property corners, bench marks and other reference points.
 - 2. If these are disturbed or destroyed during construction operations, have them replaced by a surveyor licensed in the State of North Carolina. This replacement shall be at no additional expense to the Contract.
- B. Laying out the Work.
 - 1. Locate all existing bench marks and other reference points.
 - 2. Protect these points throughout construction.
 - 3. Layout work utilizing these reference points.
- C. Record Drawings
 - 1. Maintain a record of the locations of all underground utilities and piping.
 - 2. Maintain a record of any variations of the work.
 - 3. Record Drawings shall be certified by a Land Surveyor registered in the State of North Carolina.
 - 4. Submit these Record Drawings at Project Closeout.

1.2 MAINTENANCE OF TRAFFIC

- A. Maintain vehicular and pedestrian traffic across the frontage of this project. Comply with all applicable safety requirements.

1.3 SUBMITTALS

- A. Submittals, close-out documents and O&M manuals requiring review by the architect's consultants, Contractor shall ship such documents directly to the architect and consultant.

1.4 CORRELATION OF CONSTRUCTION DOCUMENTS

- A. Review construction documents thoroughly prior to the start of construction.
- B. Report any conflict or discrepancy discovered in the Construction Documents to the Architect prior to the start of construction.
- C. Report any conflict or discrepancy discovered between the Construction Documents and state and local governmental regulations to the Architect prior to the start of construction.

1.5 PROJECT CONDITIONS

- A. The conditions existing at the time of inspection for bidding purposes will be maintained by the Owner to the extent practical. However, minor variations may occur due to natural occurrences prior to the start of work.

- B. The location of existing underground utilities indicated is approximate only. Field locate all existing underground utilities in the area of work, regardless of whether or not they are indicated. Call "NC one call" at 1-800-632-4949 prior to the start of demolition work for assistance in the location of existing underground utilities.
- C. Should charted, uncharted or incorrectly charted utilities be encountered during demolition, contact the Architect immediately for instructions. Cooperate with Owner and utility companies to keep services and facilities in operation.

PART 2 - PRODUCTS

(Not Applicable)

PART 3 – EXECUTION

3.1 PROJECT CLEAN UP

- A. Clean site as construction progresses. Do not allow trash or other waste materials to accumulate.
- B. Prior to requesting the punch-list inspection, clean the site to the following requirements:
 - 1. Power wash all walks and pavements.
 - 2. The remainder of the site shall be broom clean.
 - 3. Remove all trash and debris.

3.2 EXISTING FACILITIES

- A. Preserve existing structures, equipment, signs, markers, guardrails and fences in their original condition unless otherwise noted on the plans or unless written permission is obtained for their removal and replacement.
- B. Replace damaged items at no additional cost to the Contract.

END OF SECTION 31 02 00

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Protection of existing trees.
 - 2. Clearing and grubbing.
 - 3. Removal of trees and other vegetation.
 - 4. Topsoil stripping.

1.3 DEFINITIONS

- A. Remove: Remove and legally dispose of items indicated. Removal includes digging out and off-site disposing of stumps and roots
- B. Tree Protection Zone: The area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
- C. Topsoil: Friable, clay loam surface soil, found in varying depths.

1.4 MATERIALS OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees, plantings and other improvements adjoining the construction that might be misconstrued as damage caused by the Work.

1.6 PROJECT CONDITIONS

- A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.
- B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
 - 1. Protect existing improvements on adjoining properties and on Owner's property.
 - 2. Restore existing improvements damaged by clearing operations to their original condition.

- C. The conditions existing at the time of inspection for bidding purposes will be maintained by the Owner to the extent practical. However, minor variations may occur due to natural occurrences prior to the start of clearing work.
- D. Do not commence site-clearing operations until erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCING

- A. Tree protection fencing shall be non-tearable orange "snow fence" of 2,000 lb. tensile yield per 4 ft. width and 1,000% elongation at break complying with ASTM D638.

PART 3 – EXECUTION

3.1 Protection of Existing Trees and Vegetation

- A. Install tree protection fencing as indicated. Erect and maintain a temporary fence around the drip line of individual trees or around the perimeter drip line of groups of trees to remain.
 - 1. Do not store construction materials, debris, topsoil or other excavated material within the tree protection zone.
 - 2. Do not permit vehicles or other equipment within the tree protection zone.
 - 3. Maintain tree protection zones free of weeds and trash.
- B. Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line.
- C. Provide protection for roots over 1-1/2 inch diameter that are cut during construction operations. Coat cut faces with emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Architect.

3.2 SITE CLEARING

- A. General: Selective tree removal will be performed by the Contractor. Remaining trees, stumps, shrubs, and other debris is the responsibility of the Contractor. Remove trees, shrubs, grass and other vegetation as required to permit installation of the Work. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of the Work.
- B. Clearing and Grubbing: Clear site of trees, shrubs and other vegetation within the clearing limits indicated.
 - 1. Completely remove stumps, roots, and other debris.
 - 2. Use only hand methods for grubbing inside drip line of trees indicated to remain.

3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.

3.3 TOPSOIL STRIPPING

- A. Remove heavy growths of grass from areas before stripping.
- B. Strip topsoil to whatever depths are encountered, but to a minimum of at least 4 inches.
- C. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other material.
 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- D. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.
- E. Temporarily stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.
 1. Do not stockpile topsoil within tree protection zones.
 2. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.
- F. Dispose of unsuitable topsoil in a legal manner off-site.

3.4 DISPOSAL OF WASTE MATERIALS

- A. Burning on Owner's Property: Burning is not allowed.
- B. Removal from Owner's Property: Remove waste materials generated by clearing operations from Owner's property and dispose of in a legal manner off-site.
 1. Remove waste materials and debris from the site in a manner to prevent spillage. Pavements and the area adjacent to the site shall remain free from mud, dirt and debris at all times.
 2. Clean up debris resulting from site clearing operations continuously with the progress of the work.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.
- B. Refer to Section 311000 for topsoil stripping.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Excavation, filling, backfilling, and grading indicated and necessary for proper completion of the work.
 - 2. Preparing of subgrade for building slabs, walks, and pavements.
 - 3. Drainage/porous fill course for support of building slabs.
 - 4. Excavating and backfilling of trenches.
 - 5. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.
 - 6. Structural coordination.

1.3 SUBMITTALS

- A. NCDOT approved Job Mix for stone.
- B. Imported fill (if required): Submit location of borrow pit and a sample of the soil for approval to the Owner's Geotechnical Engineer a minimum of fourteen (14) working days prior to use

1.4 DEFINITIONS

- A. Excavation: Removal of all material (except for rock) encountered to design subgrade elevations indicated for cut areas and to subsoil elevations in fill areas. Excavation also includes subsequent re-spreading, moisture conditioning, compaction, and grading of satisfactory materials removed.
- B. Unauthorized Excavation: Removal of materials beyond the limits indicated in the definition of "Excavation" without specific direction of Architect.
- C. Additional Excavation: Removal, disposal and replacement of materials beyond the limits indicated in the definition of "Excavation" at the direction of the Architect. Refer to Part 3 of this Section for requirements of Additional Excavation.
- D. Subgrade: The undisturbed earth (in cut) or the compacted soil layer (in fill) immediately below granular subbase, drainage fill, or topsoil materials.
- E. Subsoil: The undisturbed earth immediately below the existing topsoil layer.
- F. Building Pad: The area extending 10 feet beyond the exterior limits of the building/column footings and down to undisturbed soils at a one horizontal to one vertical slope.

- G. Structures: The area extending a minimum of ten (10) feet beyond the edge of foundations, slabs, curbs, underground tanks, piping or other man-made stationary features occurring above or below ground surface.
- H. Pavements: The area extending 10 feet beyond the exterior limits of paved areas and down to undisturbed soils at a one horizontal to one vertical slope. The area extending 3 feet beyond the exterior limits of walks and down to undisturbed soils at a one horizontal to one vertical slope
- I. Subbase Material: Artificially graded mixture of crushed gravel or crushed stone meeting NCDOT specifications. Material type is indicated on the drawings.
- J. Drainage/Porous Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel meeting the requirements of NCDOT No. 57 Stone.
- K. Rock: Hard bed rock, boulders or similar material requiring the use of rock drills for removal. The criteria for classification of general excavation as rock is any material which cannot be dislodged by a Caterpillar D-8 Tractor, or equivalent, equipped with a single tooth hydraulically operated power ripper. The criteria for trench rock shall be that a Caterpillar 345 Backhoe, or equivalent, with a proper width bucket cannot remove the material.

1.5 ADDITIONAL WORK

- A. General Conditions refers to certain conditions that may require additional excavation work. This paragraph is further defined herein and, where there are conflicts, is superseded by this section.
- B. Claims for concealed, unknown, or unanticipated subsurface conditions are limited to those circumstances where:
 - 1. Additional excavation work is required below the contract limits indicated to provide acceptable bearing for structures or pavements.
 - 2. Additional excavation work below the utility trench design elevations as required to provide acceptable bearing for the utility.
 - 3. Rock is encountered between existing grade and design subgrade.
- C. The risks of concealed, unknown, or unanticipated subsurface conditions (except for rock) from existing ground surface to the design subgrade elevations in cut areas and to subsoil elevations in fill areas shall be included in the Contract Amount and shall not be considered as grounds for additional costs to the Contract. The risks of concealed, unknown, or unanticipated subsurface conditions below the elevations stated above shall be considered as Additional Excavation.
- D. During construction, if concealed, unknown, or unanticipated subsurface conditions are encountered which require that footings, foundations or other parts of the building be raised, lowered or revised to provide acceptable bearing for the building or if, outside the building limits, additional depth of utility trench excavation below the design subgrade or subsoil elevations is required, immediately notify the Architect upon discovery of such condition prior to disturbing the material encountered.

1.6 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
- B. Environmental Compliance:

1. Comply with the requirements of the latest edition of the North Carolina Erosion and Sediment Control Planning and Design Manual for erosion control during earthwork operations.
- C. Testing and Inspection Service: Owner will employ and pay for an independent Geotechnical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations. Cooperate with Owner's Geotechnical Engineer as required for testing and inspection of work. These services do not relieve the responsibility for compliance with Contract Document requirements.

1.7 PROJECT CONDITIONS

- A. Site Information: Data concerning subsurface materials or conditions, which are based on test borings, have been obtained by the Owner for his use in designing the project. This data is contained in a report titled "Geotechnical Engineering Report, Hendrick Auto Tech Building, Hamlet, North Carolina" by ECS Southeast, LLP dated October 4, 2023. This report is included in this project manual for information only.
1. The accuracy or completeness of the data is not warranted or guaranteed by the Owner or the Architect/Engineer, and in no event shall be considered part of the Contract Documents. The Owner and Architect/Engineer expressly disclaim any responsibility for the data as being representative of the conditions and materials that may be encountered.
- B. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner of others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without receiving Architect's written permission.
 3. Existing utilities across or along the line of work are indicated only in an approximate location. Locate all underground lines and structures. Call "NC one call" at 1-800-632-4949 prior to construction. If utilities are marked that are not shown on the plans, locate utility vertically and horizontally and provide information to architect. Repair and correct any damage to underground lines and structures.

1.8 SAFETY

- A. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
1. Operate warning lights as recommended by authorities having jurisdiction and governing regulations and standards.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Work within the road right-of-way shall meet all requirements of the latest edition of the North Carolina Department of Transportation Work Area Protection Manual.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D2487 USCS soil classification groups CL, GC, SC, GW, GP, GM, ML, SM, SW, and SP.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups OL, OH, and PT.
- C. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 4 inches in any dimension (2 inches for material used in trench backfill), debris, waste, frozen materials, vegetation and other deleterious matter.
- D. Imported material for structural fill shall comply with ASTM D2487 soil classification groups CL, GC, SC, GW, GP, GM, SM, SW, and SP.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 31 1000 "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls during earthwork operations.

3.2 DEWATERING

- A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrade and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use utility trench excavations as temporary drainage ditches.
- B. Should any springs or running water be encountered in the excavation, notify the Architect and provide discharge by trenches (or other acceptable means) and drain to an appropriate point of disposal. Provide temporary drainage facilities to minimize the flow of rainwater onto adjacent property. Repair any damage to property or to subgrade as a result of construction and/or dewatering (or lack thereof) operations at no additional cost to the Contract. If permanent provision must be made for disposal of water other than as indicated, the Contract price shall be adjusted.

3.3 EXPLOSIVES

- A. Blasting is not allowed.

3.4 EXCAVATION

- A. Excavation consists of removal, placement and disposal of material encountered when establishing required subgrade or finish grade elevations.
 - 1. Excavation includes removal and disposal of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
 - 2. Existing pavements void of any deleterious material may be used as structural fill as approved by the Owners Geotechnical Engineer.
- B. Rock Excavation: If Rock is encountered the Owner's Geotechnical Engineer will verify that the material qualifies for classification as rock excavation.
 - 1. If rock is encountered in grading, remove to depths as follows:
 - a. Under surfaced areas, to 6" under the respective subgrade for such areas.
 - b. Under grass and planted areas - 12" minimum.
 - c. Under footings – Two feet below bottom of footing, One foot outside of perimeter of footing.
 - d. Under trenches – 6" below bottom of trench.
 - 2. After the Owner's Geotechnical Engineer verified that the material is rock, Contractor shall employ a surveyor licensed in the State of North Carolina to calculate the quantity of material removed as Rock Excavation. The quantity of rock calculated shall not exceed the volume determined by the payment limits. The Owner's Project Representative shall review the quantity calculated within 48 hours of receiving the survey notes.

3.5 EXCAVATION FOR BUILDING PAD AND STRUCTURES

- A. Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction and for review.
- B. Excavations for footings and foundations: Do not disturb bottoms of excavation. Excavate by hand to elevations required just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 1. Where rock is encountered, carry excavation to required elevations and backfill with crushed stone prior to installation of footing.
- C. Excavation for Underground Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction and for review. Do not disturb bottom of excavations intended for bearing surface.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.
- B. Excavate trenches to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
 - 1. Where rock is encountered, carry excavation to required elevations and backfill with NCDOT #57 crushed stone prior to installation of pipe.
 - 2. For pipes or conduit less than 6 inches in nominal size, and for flat-bottomed, multiple-duct conduit units, do not excavate beyond indicated depths. Hand-excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
 - 3. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads ensure continuous bearing of pipe barrel on bearing surface.

3.8 EXCAVATION STABILITY

- A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

3.9 SUBGRADE INSPECTION

- A. Notify Construction Manager when mass, trench and footing excavations have reached required subgrade. The Construction Manager will arrange for an inspection of conditions by the Owner's Geotechnical Engineer. Alternative procedures for arranging this review may be implemented at the Owner's written option.
- B. If the Owner's Geotechnical Engineer determines that the subgrade bearing conditions are unacceptable, the Construction Manager or Owner will authorize additional excavation until suitable bearing conditions are encountered.
- C. Proof-roll subgrade with a loaded tandem-axle dump truck or other approved pneumatic tired vehicle to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Owner's Geotechnical Engineer, and replace with compacted backfill or fill as directed.

- D. Under supervision of the Owner's Geotechnical Engineer, proofroll subgrade in cut areas below the and pavement(s) with a loaded tandem-axel dump truck or other approved pneumatic tired vehicle. Should any unstable sub-soil be encountered below pavement or structures, break up the top eight inches of ground surface, pulverize, moisture-condition to optimum moisture content, and compact to percentage of maximum density as stated in Percentage of Maximum Density Requirements. Perform this work at no additional cost and/or time to the Contract.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's Geotechnical Engineer, without additional compensation.

3.10 ADDITIONAL EXCAVATION

- A. Additional Excavation (Mass): Remove excavated materials and dispose of on-site as directed by the Owner's Geotechnical Engineer, Construction Manager or Owner. Replace this excavated material with satisfactory material placed and compacted according to the requirements of the "Placement and Compaction" section.
- B. Additional Excavation in Trenches: Remove excavated materials and dispose of on-site as directed by the Owner's Geotechnical Engineer, Construction Manager or Owner. Replace this excavated material with stone.
- C. Additional Excavation in Footings: Remove excavated materials and dispose of on-site as directed by the Owner's Geotechnical Engineer, Construction Manager or Owner. Replace this excavated material with lean concrete/flowable fill or with stone extending 12 inches laterally beyond the footing in all directions.
- D. The quantity of material removed as Additional Excavation (Mass, Trench or Footing) shall be calculated by a surveyor licensed in the State of North Carolina and employed by the Contractor. The Owner's Geotechnical Engineer or Construction Manager shall review the quantity calculated within 48 hours of receiving the survey notes.
- E. Protect the subgrade during construction. During wet conditions, the subgrade soils may become saturated and soften, possibly resulting in damage to the subgrade if disturbed by equipment. Correct subgrade damaged in this manner. No additional payment will be made to correct subgrade damaged in this manner.

3.11 UNAUTHORIZED EXCAVATION

- A. Correct Unauthorized Excavation as follows:
 - 1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to Owner's Geotechnical Engineer, Construction Manager or Owner.
 - 2. Elsewhere, backfill and compact unauthorized excavations as indicated for authorized excavations of same classification unless otherwise directed by Owner's Geotechnical Engineer, Construction Manager or Owner.

3.12 STORAGE OF EXCAVATED MATERIALS

- A. Temporarily stockpile excavated materials acceptable for use as backfill and fill. Place, grade, and shape stockpiles for proper drainage. Cover to prevent windblown dust.
 - 1. Stockpile excavated materials away from edge of excavations. Do not store within the drip line of trees to remain or any other tree protection areas.

3.13 BACKFILL AND FILL

- A. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Acceptance by local authority having jurisdiction of construction below finished grade, including perimeter insulation.
 - 2. Review, approval, and recording of the locations of underground utilities.
 - 3. Removal of concrete formwork.
 - 4. Removal of shoring and bracing (including backfilling of voids with satisfactory materials).
 - 5. Removal of trash and debris from excavation.
 - 6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow or ice.
- C. Ground Surface Preparation: Remove vegetation, debris, obstructions, and deleterious materials from ground surface prior to placement of fills.
- D. Bench sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material. Plow, scarify, bench or break up sloped surfaces flatter than 1 vertical to 4 horizontal so fill material will bond with existing material.
- E. Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials indicated in Part 2 of this Section.
 - 1. Under grassed areas, use satisfactory excavated or borrow material.
 - 2. Under walks, curbs, and pavements, use satisfactory excavated or borrow material.

3.14 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. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
- D. Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the utility pipe or conduit.
- G. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- H. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- J. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.
- K. Do not backfill trenches until any required testing and inspections have been completed and Construction Manager authorizes backfilling. Backfill carefully to avoid damage or displacement of pipe systems.
- L. Under piping and conduit and equipment, use crushed stone where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
- M. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

3.15 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 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 3 percent and is too wet to compact to specified dry unit weight.
- B. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations. Maintain the moisture content of the structural fill materials to within 3% of the optimum moisture content until permanently covered.
- C. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to required density.
 1. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

2. Work wet materials as directed by the Owner's Geotechnical Engineer. Base bids on working material daily for a maximum of five days of acceptable weather.
3. No additional payment will be made for these operations.

3.16 COMPACTION OF SOIL BACKFILL AND FILLS

- A. Place backfill and fill 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. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- C. Control soil and fill compaction, providing minimum percentage of density indicated for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Owner's Geotechnical Engineer, Construction Manager or Owner if soil density tests indicate inadequate compaction.
- D. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density at a moisture content within 3% of optimum in accordance with ASTM D698:
 1. Under structures and pavements, compact each layer of backfill or fill material at 95 percent maximum density. The top 12" under structures and pavements shall be compacted to 98 percent maximum density.
 2. Under grass or unpaved areas, compact each layer of backfill or fill material at 90 percent maximum density.
- E. Seal all fill areas at the end of each working day, utilizing a smooth drum roller.

3.17 GRADING

- A. General: Rough grading of areas within the Project, including cut and fill sections and adjacent transition areas, shall be reasonably smooth, compacted and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from either blade-grader or motor patrol except as otherwise indicated. The finished subgrade surface from the grassed areas generally shall be not more than 0.2 feet above or below the final grade or approved cross section, with due allowance for topsoil.
- B. The tolerance for areas within 10 feet of building perimeter, walks and all areas to be paved shall not exceed 0.10 feet above or below the established subgrade. Finish all ditches, swales and gutters to drain readily. Unless otherwise indicated, evenly slope the subgrade to provide drainage away from building walls in all directions at a grade not less than 1/4 inch per foot. Provide rounding at top and bottom of cut and fill slopes and at other breaks in grade.
- C. Protection of Graded Areas: Protect newly graded areas and areas of cut, fill and design/subgrade elevations from the actions of the elements and from deterioration as a result of construction operations and weather conditions (frost, rains, snow, sleet, hail, etc.). Repair any settlement or washing that occurs prior to or after acceptance of the work. Fill to required subgrade levels any areas where settlement occurs. Protect trees to remain, and, at all areas of the Site where

construction operations are in progress, provide protection for the safety of occupants of the existing facilities.

- D. 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.
- E. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch (25 mm).
 - 2. Walks: Plus or minus 1 inch (25 mm).
 - 3. Pavements: Plus or minus 1/2 inch (13 mm).

3.18 PAVEMENT SUBBASE COURSE

- A. General: Place subbase material, in layers of indicated thickness, over subgrade surface to support a pavement base course.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least at 12" width of shoulder simultaneously with compacting and rolling each layer of subbase course.
- D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
- E. When a compacted subbase course is 6" thick or less, place material in a single layer. When more than 6" thick, place material in equal layers, except no single layer more than 6" or less than 3" in thickness when compacted.
- F. Place subbase course on subgrades free of mud, frost, snow, or ice.
- G. 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. Place base course material over subbase course under hot-mix asphalt pavement.
 - 3. Shape subbase course to required crown elevations and cross-slope grades.
 - 4. Place subbase course 6 inches (150 mm) or less in compacted thickness in a single layer.
 - 5. Place subbase course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
 - 6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 ASTM D 1557.

- H. Pavement Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 ASTM D 1557.

3.19 BUILDING SLAB DRAINAGE COURSE

- A. Refer to Specification 033000 – Cast-in-Place Concrete.

3.20 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
 - 1. If in the opinion of the Architect, based on testing service reports and inspection, subgrade or fills have been placed that are below required density, perform additional compaction and testing until required density is obtained.
- B. The Owner will engage, and pay for, the services of a Geotechnical Engineer whose function shall be to afford complete engineering control by testing of the conditions of all footing subgrades, the placement of all structural fills under structures, and pavement areas, and all compaction where required, and to observe the proof rolling of the pavement areas.
- C. The Owner's Geotechnical Engineer will be present as deemed necessary during all phases of the Work requiring filling, compaction operations or testing. The Geotechnical Engineer will provide the Architect with written certification that fill and compaction was completed with accepted materials in accordance with the Documents, and give a professional opinion regarding shrinkage or settlement of fill and safe load bearing capacity of fill.
- D. Site Preparation and Proofrolling: The Owner's Geotechnical Engineer will determine if any additional excavation or in-place densification is necessary to prepare a subgrade for fill placement for slab or pavement support.
- E. Fill Placement and Compaction: The Owner's Geotechnical Engineer will witness all fill operations and take sufficient in-place density tests to verify that the indicated degree of fill compaction is achieved. The Owner's Geotechnical Engineer will observe and approve borrow materials used and shall determine if their existing moisture contents are suitable/acceptable.
- F. The Owner's Geotechnical Engineer will submit three (3) copies each of his reports, recommendations and/or opinions to the Architect/Engineer, Construction Manager and the Owner. Pertinent information will be provided to the Contractor as required.

3.21 EROSION CONTROL

- A. Provide erosion control methods in accordance with requirements of authorities having jurisdiction, the North Carolina Erosion and Sediment Control Handbook, and as indicated in the Contract Documents.

3.22 PROTECTION

- A. Repair and reestablish grades in settled, eroded, and rutted areas to indicated tolerances.

- B. Reconditioning Compacted Areas: Where subsequent construction operations or adverse weather disturbs completed compacted areas, scarify surface, reshape, and compact to required density prior to further construction.
- C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.
- D. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.23 DISPOSAL OF WASTE MATERIALS

- A. Removal from Owner's Property: Remove excess and/or waste materials, including trash and debris, and dispose of it off Owner's property in a legal manner.
- B. Dispose of excess material and materials not acceptable for use as backfill or fill legally offsite.
- C. Do not remove topsoil from site until it has been demonstrated to the Owner's satisfaction that it is excess.

END OF SECTION 31 20 00

SECTION 31 25 00 - EROSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.
- B. The North Carolina Erosion and Sediment Control Planning and Design Manual, latest edition.

1.2 SUMMARY

- A. This Section includes the installation, maintenance and removal of erosion control measures required for prevention of sediment leaving the project site.

1.3 EROSION AND SEDIMENT CONTROL PERMIT

- A. Prior to commencement of work, obtain a copy of the approved Erosion and Sediment Control Plan from the North Carolina Department of Environmental Quality.
- B. Schedule a pre-construction conference on-site with the Architect, Owner, Construction Manager, Engineer, and North Carolina Department of Environmental Quality Erosion Control Inspector. Hold this meeting prior to the start of any construction activities.

1.4 SUBMITTALS

- A. Completed NCDEQ Financial Responsibility / Ownership Form.
- B. Copies of the weekly Erosion Control Measure inspection reports.
- C. Applicable Erosion Control Products.

1.5 GENERAL CONTRACTOR REQUIREMENTS FOR CONSTRUCTION ACTIVITY POLLUTION PREVENTION (CAPP)

- A. Provide Description of compliance with EPA CONSTRUCTION GENERAL PERMIT (CGP) or comparison of local standards and codes with EPA CGP and description of how project complies with local standards and codes.
- B. Establish control measures before construction begins to reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust. Implement additional measures as needed based on site conditions and as construction progresses.
- C. Monitor control measures periodically through site inspections and record maintenance activities taken during construction. Inspections must be recorded regularly via date-stamped photographs, inspection reports, or other recording processes.
- D. The following actions are also recommended:
 - 1. Any problems identified in site inspections should be resolved in a timely manner.
 - 2. Inspections should follow the requirements of the CGP, Section 4.1.

3. All subcontractors should promptly notify the responsible party if they see damage to an erosion and sedimentation control (ESC) measure.
4. Generate and save documentation as the plan is implemented for eventual use in the certification submission.
5. Documentation:
 - a) Track implementation of the ESC plan by keeping written records or date-stamped photographs. A narrative description of ESC plan implementation should include the following:
 - (1) Timing of the implementation of the plan
 - (2) Specific control measures applied on site
 - (3) Maintenance protocols used to ensure the proper function of control measures

PART 2 - PRODUCTS

2.1 EROSION CONTROL PRODUCTS

A. Safety Fence

1. Four foot high non-tearable orange plastic.
2. Post appropriate warning signs along the Safety Fence.
- 1.

B. Construction Entrance

1. Heavy-duty stone aggregate and filter fabric construction entrance, complying with the requirements of Section 6.06 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
2. The water source for washing operations shall be the responsibility of the Contractor.

C. Sediment Fence

1. Synthetic filter fabric, complying with the requirements of Section 6.62 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
2. Steel posts 1.33 lb/lf with a minimum length of 5 feet.

D. Wire Reinforced Silt Fence

1. Synthetic filter fabric, complying with the requirements of Section 6.62 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
2. Steel posts 1.33 lb/lf with a minimum length of 5 feet.
3. Wire fence reinforcement shall be a minimum of 14-gauge and have a maximum mesh spacing of six inches.

E. Storm Drain Inlet Protection

1. Hardware cloth and gravel inlet protection, complying with the requirements of Section 6.51 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
2. Block and Gravel Curb Inlet Sediment Filter complying with the requirements of Section 6.52 of the North Carolina Erosion and Sediment Control Planning and Design Manual.

- F. Diversion Dike
 - 1. A dike or dike channel constructed along the perimeter of a disturbed construction area, complying with Section 6.22 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
- G. Temporary Diversion
 - 1. A temporary ridge or excavated channel or combination ridge and channel constructed across sloping land on a predetermined grade, complying with Section 6.20 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
- H. Temporary Sediment Trap
 - 1. A small, temporary ponding basin formed by an embankment or excavation to capture sediment, complying with Section 6.60 of the North Carolina Erosion and Sediment Control Planning and Design Manual and to the details indicated on the Drawings.
- I. Temporary Slope Drain
 - 1. A tubing or conduit extending temporarily from the top to the bottom of a cut or fill slope, complying with the requirements of Section 6.32 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
 - 2. Pipe shall be smooth lined polyethylene, complying with the requirements of ASTM F667 or AASHTO M294.
- J. Outlet Protection
 - 1. A structure designed to control erosion at the outlet of a channel or conduit, complying with Section 3.40.1 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
- K. Riprap
 - 1. A layer of stone designed to protect and stabilize areas subject to erosion, complying with Section 6.15 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
 - 2. The size of the stone required is indicated on the drawings.
- L. Check Dam
 - 1. A small temporary stone dam constructed across a drainage way, complying with the requirements of Section 6.83.1 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
 - 2. Check dams shall be placed on filter fabric.
- M. Dewatering Structure
 - 1. A temporary filtering device used for dewatering operations, complying with the requirements of Sections 6.62 and 6.65 of the North Carolina Erosion and Sediment Control Planning and Design Manual.
- N. Temporary Seeding
 - 1. Planting rapid growing annual grasses, small grains or legumes to provide initial temporary cover for erosion control on disturbed areas, complying with Section 6.10 of the North Carolina Erosion and Sediment Control Planning and Design Manual.

PART 3 - EXECUTION

3.1 INSTALLATION OF EROSION CONTROL MEASURES

- A. Install all erosion and sediment control measures per the requirements of the North Carolina Erosion and Sediment Control Planning and Design Manual.
- B. Protect all points of construction ingress and egress to the site to prevent tracking of mud onto public streets. Provide temporary construction entrances at all points of access to the site.
- C. Clear only those areas necessary for installation of the perimeter erosion control measures. The balance of the site shall not be cleared or otherwise disturbed until the perimeter erosion control measures are installed, functional and approved by the City of Charlotte Erosion Control Inspector.
- D. Follow the construction sequence and install erosion control measures as indicated on the Drawings and as directed by the City of Charlotte Erosion Control Inspector.
- E. Install additional measures as necessary to prevent sediment from leaving the project site.

3.2 MAINTENANCE OF EROSION CONTROL MEASURES

- A. Maintain all erosion and sediment control measures per the requirements of the North Carolina Erosion and Sediment Control Planning and Design Manual.
- B. At a minimum, the following maintenance is required:
 - 1. Safety Fence
 - a. Review fence regularly for damage. Repair any damage immediately.
 - b. Secure the fence at the end of each working day. Repair or replace all locking devices as necessary.
 - 2. Construction Entrance
 - a. Wash and rework stone and/or place additional stone as required to prevent tracking of mud onto the roadways.
 - b. Clean out the sediment-trapping device for the washrack.
 - c. Remove all materials spilled, dropped, washed or otherwise tracked onto roadways or into storm sewers immediately. Do not use water trucks to wash the roadways.
 - 3. Sediment Fence
 - a. Inspect immediately following each rainfall and at least daily during prolonged rainfall.
 - b. Make any required repairs immediately. Give special attention to damage resulting from end-runs and undercutting.
 - c. Replace fabric that is decomposing or is otherwise ineffective.
 - d. Clean out accumulated sediment following every storm event. Do not allow sediment to accumulate higher than one-half the height of the barrier.
 - 4. Wire Reinforced Sediment Fence
 - a. Inspect immediately following each rainfall and at least daily during prolonged rainfall.
 - b. Make any required repairs immediately. Give special attention to damage resulting from end-runs and undercutting.

- c. Replace fabric that is decomposing or is otherwise ineffective.
 - d. Clean out accumulated sediment following every storm event. Do not allow sediment to accumulate higher than one-half the height of the barrier.
5. Storm Drain Inlet Protection
 - a. Inspect immediately following each rainfall and at least daily during prolonged rainfall.
 - b. Remove and clean or replace stone filters that have been clogged with sediment. Make any required repairs immediately
 - c. Remove accumulated sediment as required. Do not allow sediment to accumulate higher than one-half the height of the measure.
6. Temporary Diversion Dike
 - a. Inspect immediately following each rainfall and at least daily during prolonged rainfall. Inspect at least once every two weeks, whether or not it has rained. Make any necessary repairs immediately.
 - b. Repair damages caused by construction activities by the end of each working day.
7. Temporary Diversion
 - a. Review measure at the end of each working day to ensure its effective operation.
 - b. Remove accumulated sediment and make repairs as necessary.
 - c. Re-seed as necessary to maintain vegetative cover.
8. Temporary Sediment Trap
 - a. Remove sediment and restore the trap to its original dimensions once the sediment accumulates to the cleanout level. Refer to the drawings for the appropriate cleanout level elevations.
 - b. Any pumping shall be discharged through an approved dewatering structure.
 - c. Remove and clean or replace stone choked with sediment.
 - d. Regularly check the structure to ensure that it is structurally sound. Immediately repair any damage discovered.
9. Temporary Slope Drain
 - a. Inspect the temporary slope drains weekly and following every storm event. Immediately make any necessary repairs to ensure a free flow through the pipe.
10. Outlet Protection
 - a. Inspect outlet protection following every storm event. Re-lay riprap as necessary to prevent concentrated flow from running across the outlet protection.
11. Riprap
 - a. Inspect riprap following every storm event. Re-lay riprap as necessary to prevent concentrated flow from running under or around the riprap.
 - b. Clean out accumulated sediment from the riprap.
12. Check Dams
 - a. Inspect immediately following each rainfall and at least daily during prolonged rainfall.
 - b. Remove and clean or replace stone that has been clogged with sediment.
 - c. Inspect for evidence of by-pass flows. Make any required repairs immediately
 - d. Remove accumulated sediment as required. Do not allow sediment to accumulate higher than one-half of the height of the dam.

13. Dewatering Structure
 - a. Repair or replace the filtering media to prevent sediment accumulation from affecting the filtering capacity of the structure.
 14. Temporary Seeding
 - a. Re-seed and mulch areas where cover is inadequate to protect against erosion until adequate cover is obtained.
- C. Remove accumulated sediment as required and at appropriate intervals to maintain the effective function of all erosion control measures.
- D. Inspect, repair and remove accumulated sediment from erosion control measures following significant (greater than ½") rainfall events.
- E. If erosion control measures become clogged, causing the impoundment of water, restore the measures immediately. Pounded water poses a potential drowning hazard and shall be relieved immediately by either pumping (through an approved dewatering structure) or by removal of the blockage.

3.3 REMOVAL OF EROSION CONTROL MEASURES

- A. Remove all temporary erosion control measures following the stabilization of the site. Do not remove erosion control measures until authorized by the North Carolina Department of Environmental Quality Erosion Control Inspector.
- B. Topsoil, permanently seed and stabilize areas occupied by erosion control measures.

3.4 DUST CONTROL

- A. Minimize dust from construction operations.
- B. During the performance of the work, whether within right of way or elsewhere, contractor shall furnish labor, equipment and materials to control dust at all times including evenings, holidays and weekend.
- C. Contractor shall be liable for any damage resulting from dust originating from contractor's operations.

END OF SECTION 31 25 00

SECTION 31 31 00 – SOIL TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes soil treatment for termite control.

1.2 SUBMITTALS

- A. Product Data: For each product indicated, including EPA-Registered Label.
- B. Product certificates.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following as applicable:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Brand name and manufacturer of termiticide.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes, and rates of application used.
 - 6. Areas of application.
 - 7. Water source for application.

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications: A pest control operator who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located.
- B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with EPA regulations and authorities having jurisdiction.

1.4 WARRANTY

- A. Soil Termiticide Special Warranty: Manufacturer's standard form, signed by applicator and Contractor, certifying that applied soil termiticide treatment will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered within three years from date of Substantial Completion, re-treat soil and repair or replace damage caused by termite infestation.

PART 2 - PRODUCTS

2.1 TERMITE CONTROL

- A. Soil Treatment: EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent. Use only soil treatment solutions that are not harmful to plants.
 - 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:
 - a. BASF Corporation.
 - b. Bayer Environmental Science
 - c. Ensystem
 - d. Syngenta

PART 3 - EXECUTION

3.1 PREPARATION

- A. 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 and around foundations.

3.2 SOIL TREATMENT APPLICATION

- A. Apply soil treatment at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA-Registered Label.
 - 1. Mix termiticide solution to a uniform consistency.
 - 2. Apply to produce a continuous horizontal and vertical termiticidal barrier or treated zone around and under building construction. Distribute the treatment evenly.
 - 3. 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.
 - 4. Foundations: Adjacent soil including soil along entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers, piers, and chimney bases; and along entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
 - 5. Crawlspace: Soil under and adjacent to foundations. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
 - 6. Masonry: Treat voids.
 - 7. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
- B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- C. 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.
- D. Post warning signs in areas of application.

- E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 31 31 00

Division 32 – Exterior Improvement

SECTION 32 12 16 - ASPHALT PAVEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

- A. This Section includes the following:
 1. Hot-mix asphalt paving over prepared subbase.
 2. Hot-mix asphalt patching.
 3. Hot-mix asphalt overlays.
 4. Asphalt surface treatments.
 5. Pavement-marking paint.

1.3 SUBMITTALS

- A. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- B. Material Certificates: For each paving material, from manufacturer.
- C. Traffic maintenance and Work Area Protection Plan

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by NCDOT.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of SRSS of NCDOT for asphalt paving work.
 1. Measurement and payment provisions included in NCDOT SRSS do not apply to this Section.
 2. SRSS requirements supersede all information and requirements of this specification section.
- D. Preinstallation Conference: Conduct conference at Project site prior to beginning paving operations.

- E. Asphalt paving materials and installation shall conform to the requirements of the latest edition of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Tack Coats: Minimum surface temperature of 60 deg F.
 - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 ASPHALT-AGGREGATE MIXTURE

- A. Aggregate to comply with NCDOT SRSS, Article 1012-1.

2.2 ASPHALT MATERIALS

- A. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- B. Prime Coat: Asphalt emulsion prime conforming to NCDOT requirements.

2.3 AUXILIARY MATERIALS

- A. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
 - 1. Color: Per regulatory requirement or Owner.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes. Refer to construction plans for type and thickness of asphalt mixes. Refer to NCDOT SRSS for mix design.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Proceed with paving only after approved by Geotechnical Engineer of the subgrade and unsatisfactory conditions have been corrected.

3.2 PATCHING AND REPAIRS

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade. Geotechnical Engineer must approve subgrade compaction prior to paving.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.08 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving. Geotechnical Engineer must approve subgrade compaction prior to paving.
- B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.04 to 0.08 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Prime Coat: Apply uniformly over surface of compacted unbound aggregate base course at a rate of 0.20 to 0.50 gal./sq.yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure for 72 hours minimum.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off.

- B. Place paving in consecutive strips.
- C. Promptly correct surface irregularities in paving course behind paver.

3.5 JOINTS

- A. Construct joints between old and new pavement.

3.6 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve indicated density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference laboratory density according to NCDOT requirements.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm. Surface course average density shall be 92 percent of reference laboratory density.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method. Edges adjacent to curbs and curb and gutter sections shall be flush with the edge of concrete.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.

2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.8 PAVEMENT MARKING

A. Refer to section 321700 – Pavement Markings, Signs and Specialties.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 32 12 16

SECTION 32 13 13 - SITE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.

1.2 DESCRIPTION OF WORK:

- A. Extent of Portland cement concrete paving is shown on drawings, including:
 1. Curbs and gutters
 2. Walkways
 3. Service area pavement.

1.3 SUBMITTALS

- A. Provide certification that all materials meet NCDOT standards for the class of concrete required.

1.4 JOB CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
 1. Use flexible spring steel forms or laminated boards to form radius bends as required.
 2. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185.
- C. Reinforcing Steel: ASTM A 615, Grade 60, deformed
- D. Concrete Materials: Comply with requirements of section 033000 – Cast-In-Place Concrete.
- E. Expansion Joint Materials: Comply with requirements of applicable NCDOT Standard Specifications for Roads and Structures for preformed expansion joint fillers and sealers.

- F. Anti-spalling Compound: Combination of boiled linseed oil and mineral spirits, complying with AASHTO M-233.
- G. Liquid-Membrane Forming and Sealing Curing Compound: Comply with NCDOT Standard Specifications for Roads and Structures.

2.2 CONCRETE MIX, DESIGN, AND TESTING

- A. Comply with requirements of section 033000 – Cast-In-Place Concrete, and NCDOT Standard Specifications for Roads and Structures whichever is more stringent.
- B. Design mix to produce normal-weight concrete consisting of Portland cement, aggregate, water-reducing or high-range water-reducing admixture (superplasticizer), air-entraining admixture, and water to produce the following properties:
 - 1. Comply with the requirements of NCDOT Standard Specifications for Roads and Structures, unless otherwise indicated.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.2 FORM CONSTRUCTION

- A. Set forms to required grades and lines, braced and secured. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
- B. Check completed formwork for grade and alignment to following tolerances:
 - 1. Top of forms not more than 1/8 inch in 10 feet.
 - 2. Vertical face on longitudinal axis, not more than 1/4 inches in 10 feet.
- C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 REINFORCEMENT

- A. Locate, place and support reinforcement as specified in NCDOT Standard Specifications for Roads and Structures, unless otherwise indicated.

3.4 CONCRETE PLACEMENT

- A. General: Comply with requirements of section 03 30 00 – Cast-In-Place Concrete and NCDOT Standard Specifications for Roads and Structures whichever is more stringent.
- B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- C. Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
- D. Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than 1/2 hour, place a construction joint.
- E. Fabricated Bar Mats: Keep mats clean and free from excessive rust, and handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.
- F. Place concrete in 2 operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
- G. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect.
- H. Curbs and Gutters: Automatic machine may be used for curb and gutter placement. If machine placement is to be used, submit revised mix design and laboratory test results that meet or exceed minimums indicated. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as indicated for formed concrete. If results are not acceptable, remove and replace with formed concrete meeting requirements.

3.5 JOINTS

- A. General: Construct expansion, weakened-plane (contraction), and construction joints true to line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.
- B. Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints, sectioning concrete into areas as shown on drawings. Construct weakened-plane joints for a depth equal to at least 1/4 concrete thickness, as follows:
 - 1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.
 - 2. Sawed Joints: Form weakened-plane joints with powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
 - 3. Inserts: Use embedded strips of metal or sealed wood to form weakened-plane joints. Set strips into plastic concrete and carefully remove strips after concrete has hardened.

- C. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for more than 1/2 hour, except where such placements terminate at expansion joints.
 - 1. Construct joints as indicated or, if not indicated, use standard metal keyway-section forms.
- D. Expansion Joints: Provide pre-molded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks, and other fixed objects, unless otherwise indicated.
- E. Locate expansion joints at 30 feet o.c. for each pavement lane unless otherwise indicated.
- F. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.
- G. Provide joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
- H. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.
- I. Fillers and Sealants: Comply with requirements of NCDOT Standard Specifications for Roads and Structures for preparation of joints, materials, installation, and performance.
- J. Refer to Drawings for scoring patterns for:
 - 1. Concrete shall be scored in 5' intervals unless otherwise indicated on the civil or architectural drawings.

3.6 CONCRETE FINISHING

- A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.
- B. After floating, test surface for trueness with a 10-ft. straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.
- C. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.
- D. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surface as follows:
 - 1. Broom finish by drawing a fine-hair broom across concrete surface perpendicular to line of traffic. Repeat operation to provide a fine line texture.
- E. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Architect.

3.7 CURING

- A. Protect and cure finished concrete paving in compliance with Section 033000 – Cast-In-Place Concrete. Use membrane-forming curing and sealing compound or approved moist-curing methods.

3.8 REPAIRS AND PROTECTIONS

- A. Repair or replace cracked, broken or defective concrete curbs and curb and gutter, as directed by Architect.
- B. Replace cracked, broken or defective concrete sidewalks, as directed by Architect.
- C. Repair or replace cracked, broken or defective concrete pavement, as directed by Architect.
- D. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.
- E. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- F. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just before final inspection.

END OF SECTION 32 13 13

SECTION 32 17 00 - PAVEMENT MARKINGS, SIGNS AND SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 1. Establishing the location of pavement markings and applying pavement markings for parking space lines, traffic control, fire lane and accessible spaces.
 2. Installation of signs for traffic control and accessible spaces.
 3. Installation of wheel stops at parking spaces.
 4. Installation of permanent raised pavement markers

1.3 QUALITY ASSURANCE

- A. All work and materials shall conform to the requirements of the latest edition of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures.
- B. All materials for signs shall conform to the requirements of the latest edition of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures (and to the requirements of the latest edition of the Manual of Uniform Traffic Control Devices for traffic signs.
- C. Installer Qualifications: Engage an experienced installer, who has successfully completed striping and signage projects similar in size and complexity to this project. The installer's primary business (defined as a minimum of 60% of total billings) shall be striping and signage.

1.4 SUBMITTALS

- A. Product Data and written confirmation that the following materials are included on NCDOT's list of approved construction materials:
 1. Pavement marking paint
 2. Wheel stops
 3. Signs
 4. Posts
 5. Raised Pavement Markers
 6. Installer Qualifications

PART 2 - PRODUCTS

2.1 PAVEMENT MARKING PAINT

- A. Paint shall conform to the requirements of Division 12 of the (NCDOT) Standard Specifications for Roads and Structures and Federal Specification TT-P-1952. Color shall be selected by Owner from colors acceptable to the authorities having jurisdiction.
- B. Thermoplastic lane markings are required within NCDOT rights-of-way.

2.2 PAINT APPLICATOR

- A. Provide hand-operated push-type applicator machine of a type commonly used for application of paint to pavement surfaces. Paint applicator machine shall be acceptable for marking small street and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles and shall be capable of applying paint uniformly at coverage specified.

2.3 WHEEL STOPS

- A. Wheel stops shall be made of 3,000 psi precast concrete and be 6 inches high, 8 inches wide and approximately 6 feet long. Provide chamfered corners and edges and two holes for anchoring.

2.4 SIGNS AND POSTS

- A. Signs shall conform to the requirements of NCDOT Standard Specifications for Roads and Structures. Signs shall be fabricated with encapsulated lens sheeting.
- B. Signposts for traffic control signage shall be 3 lb steel u-channel post conforming to the requirements of NCDOT Standard Specifications for Roads and Structures.
- C. Utilize steel posts for fire-lane signage and for signage at accessible parking spaces.

2.5 CONCRETE

- A. Concrete shall be Class A, General concrete, conforming to the requirements of NCDOT Standard Specifications for Roads and Structures

2.6 RAISED PAVEMENT MARKERS

- A. Raised pavement markers shall be constructed of either injected molded plastic body and base, plastic shell filled with a mixture of inert thermosetting compound and filler material or ceramic.
- B. Shall conform to ASTM D4280.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION FOR PAVEMENT MARKING

- A. Apply pavement markings only when the ambient temperatures is above 50°F and less than 95°F, unless otherwise approved.
- B. Allow pavement to cure for a period of not less than 7 days before applying pavement marking or according to manufacturer's recommendations.
- C. Clean surfaces thoroughly before application of paint. Remove, dust, dirt and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required.
- D. Remove existing pavement markings, residual curing compounds and other coating adhering to the pavement with scrapers, wire brushes, waterblasting, sandblasting or mechanical abrasion as required. Areas of existing pavement affected by oil or grease shall be scrubbed with an approved chemical and rinsed thoroughly. Seal oil-soaked areas with shellac or primer after cleaning.
- E. Pavement surfaces shall be dry and clean prior to painting. Pavement markings shall not be applied within 24 hours following rain or other inclement weather or when rain is imminent.
- F. Apply seal coat across the existing pavement to provide a uniform surface appearance.

3.2 APPLICATION OF PAVEMENT MARKING

- A. Apply paint in accordance with the requirements of NCDOT Standard Specifications for Roads and Structures.
- B. Lay out lines and markings to the width and length as indicated. All parking space lines shall be 4 inches wide.
- C. Apply paint with an approved paint applicator.
- D. Apply paint at manufacturer recommended rates to provide a minimum 15 mil wet thickness.

3.3 FIRE LANE MARKINGS AND SIGNAGE

- A. Mark fire lanes and install fire lane signage in accordance with the requirements of the local Fire Marshall and as indicated on the drawings.

3.4 INSTALLATION OF WHEEL STOPS

- A. Secure wheel stops with two 1/2-inch diameter steel reinforcing rods. Rods shall be a minimum of 18 inches in length and be embedded into the pavement, base and subgrade a minimum of 12 inches and be flush with the top of the bumper block.

3.5 INSTALLATION OF SIGNS

- A. Install signs on signposts in accordance with the requirements of NCDOT Standard Specifications for Roads and Structures.
- B. Install signposts in concrete foundation to a depth of 3 feet minimum by 12 inches in diameter.

3.6 INSTALLATION OF PERMANENT RAISED PAVEMENT MARKERS

- A. Install permanent raised pavement markers with hot bitumen adhesive. Shall meet requirements of NCDOT Standard Specifications for Roads and Structures, Article 1081.3.

END OF SECTION 32 17 00

SECTION 32 92 00 – LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Fine grading and preparing lawn areas
 - 2. Topsoil Placement
 - 3. Soil amendments
 - 4. Fertilizers
 - 5. Sodding
 - 6. Hydroseeding

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Lawns: All areas disturbed by construction and not otherwise covered by paving, buildings or other structures.

1.4 SUBMITTALS

- A. Certification by product manufacturer that the following products supplied comply with requirements:
 - 1. Turfgrass Sod
 - a. Certification of each seed mixture for turfgrass sod stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- B. Topsoil Amendment Plan.
 - 1. Provide copy of topsoil testing report.
 - 2. List of amendments proposed for topsoil, including application rates.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer, who has successfully completed lawn establishment projects similar in size and complexity to this project. The installer's primary business (defined as a minimum of 60% of total billings) shall be establishment of lawns.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Sod: Harvest, deliver, store and handle sod according to requirements in TPI's Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding". Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage or drying.

1.7 PROJECT CONDITIONS

- A. Do not install lawns during rainy or freezing weather, or when soil is frozen.

1.8 TIMING OF INSTALLATION

- A. Sod:
 - 1. Immediately after finish grading is accepted.
 - 2. Allow sufficient time for sod to knit together and meet requirements for preliminary review.

1.9 WARRANTY

- A. Time Period: Warrant that lawns are in healthy and flourishing condition of vigorous active growth one year from date of Final Acceptance.
- B. Appearance During Warranty: Lawns shall be free of dead or dying patches, and all areas shall show foliage of a normal density, size and color.
- C. Delays: Delays caused by the Contractor in completing planting operations which extend the planting into more than one planting season shall extend the Warranty Period correspondingly.
- D. Exceptions: Contractor shall not be held responsible for failures due to neglect by Owner, vandalism, or Acts of God during Warranty Period. Report such conditions in writing.

1.10 MAINTENANCE SERVICE

- A. Initial Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 - 1. Seeded Lawns: 60 days from date of planting completion.
 - a. When initial maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

2. Sodded Lawns: 30 days from date of planting completion.

PART 2 – PRODUCTS

2.1 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 6.5, a minimum of 4 percent organic material content; free of stones 1” or larger in any dimension and other extraneous materials harmful to plant growth.
 1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.
- B. Have topsoil tested by a certified soil testing laboratory to determine the type and quantity of soil amendments necessary. Add amendments to topsoil as necessary to meet these requirements.

2.2 INORGANIC SOIL AMENDMENTS

- A. If the topsoil analysis indicates the need for inorganic soil amendments, the following standards apply:
- B. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 1. Class: Class O, with a minimum 95 percent passing through No. 8 (2.36-mm) sieve and a minimum 55 percent passing through No. 60 (0.25-mm) sieve.
 2. Provide lime in form of dolomitic limestone.
- C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 (3.35-mm) sieve and a maximum 10 percent passing through No. 40 (0.425-mm) sieve.
- D. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- E. Aluminum Sulfate: Commercial grade, unadulterated.
- F. Perlite: Horticultural perlite, soil amendment grade.
- G. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- H. Sand: Clean, washed, natural or manufactured, free of toxic materials.

- I. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- J. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

- A. If the topsoil analysis indicates the need for organic soil amendments, the following standards apply:
- B. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch (19-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
 - 3. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
 - 4. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
 - 5. Manure: Well-rotted, un-leached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.4 HERBICIDES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.5 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in topsoil analysis reports from a qualified soil-testing agency.
 - 2. Minimum Composition: No less than 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2.6 LAWN SOD

- A. One year old nursery-grown sod that is certified Common Bermuda.
- B. Dense, healthy, field-grown on fumigated soil with the grass having been mowed at 1-inch height before lifting from field.
- C. Dark green in color, free of thatch, free from diseases, weeds and harmful insects.
- D. Reasonably free of objectionable grassy and broad leaf weeds. Sod shall be considered weed free if no more than ten (10) such weeds are found per 100 sq. ft. of sod.
- E. Sod shall be rejected if found to contain the following weeds:
 - 1. Quackgrass.
 - 2. Johnson grass.
 - 3. Poison ivy.
 - 4. Nimbleweed.
 - 5. Thistle.
 - 6. Bindweed.
 - 7. Bentgrass.
 - 8. Perennial sorrel.
 - 9. Bromegrass.
- F. All sod to be cut 1-1/2 inches deep. Rhizome development should be apparent.

2.7 GENERAL ACCESSORIES

- A. Water: Potable water as furnished by Owner.
- B. Pre-plant Fertilizer: See Soil Preparation - Section 329113
- C. Top-Dress Fertilizer: 16-6-8 (N-P-K)
- D. Herbicides: Do not use herbicides which persist in the ground longer than 30 days.

2.8 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Pine Straw: Fresh, dry and free from debris, pine cones, or soil. Slash Pine is preferred.
- C. Peat Mulch: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and for conditions affecting performance of the Work. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 1. Grades: Verify that grades are within 1-inch plus or minus the required finished grades. Verify that all soil preparation has been completed and approved. Report all variations in writing.
 - 2. Stones, Weeds, Debris: Verify that all areas to receive lawns and grasses are clear of stones larger than 1-1/2 inch in diameter, weeds, debris, and other extraneous materials.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, restore areas if eroded or otherwise disturbed after finish grading.

3.3 TOPSOIL PLACEMENT FOR LAWNS

- A. Limit subgrade preparation to areas that will be planted in the immediate future.
- B. Loosen subgrade to a minimum depth of 4 inches. Remove stones, sticks and roots larger than 2 inches in any dimension from subgrade, 1" in playing fields. Completely remove trash and other extraneous debris from subgrade.
- C. Have topsoil tested by a certified soil testing laboratory to determine the type and quantity of soil amendments necessary.
- D. Sift topsoil to remove stones and other objects larger than 1" in any dimension. Sift topsoil to remove stones and other objects larger than 1/2" in any dimension in all playing fields. Maximum object size for topsoil shall be achieved by sifting not by hand removal or raking following placement of topsoil.
- E. Mix soil amendments and fertilizers with topsoil at rates required by soil testing. Delay mixing fertilizer if planting does not follow placing of planting soil within 4 days. Either mix soil before spreading or apply soil amendments on surface of spread topsoil and mix thoroughly into top 4 inches (100 mm) of topsoil before planting.
- F. Mix lime with dry soil prior to mixing fertilizer.
- G. Spread topsoil to a minimum depth of six inches (6").

3.4 SODDING

- A. Sod Bed Preparation:

1. Rolling: Roll amended soil with 200 pound water-ballast roller.
2. Moistening Soil Surface: After all unevenness in the soil surface has been corrected, lightly moisten the soil immediately prior to laying the sod.
3. Timing: Sod immediately thereafter, provided the sod bed has remained in friable condition.

B. Sodding Operations:

1. Big roll sod shall be installed by tractors with proper flotation tires or by an approved big roll sod installation machine. Care should be taken to roll out sod at a proper speed so that no humping or tearing of sod occurs. Sod will be manually pulled together by stiff rakes to insure no gaps remain in the seams. Joints should be staggered. Damaged or problem areas shall be cut out and replaced in a professional manner.
2. Starter Strip: a. Lay first row of sod in a straight line, with subsequent rows parallel to and tightly against each other. b. Stagger lateral joints. c. Do not stretch or overlap sod. d. Butt all joints tightly to eliminate all voids.
3. Cutting: Use a sharp knife to cut sod to fit curves, surface components of the irrigation system or other items.
4. Tamping and Rolling: Thoroughly tamp and roll sod to make contact with sod bed. Roll each entire section of completed sod.
5. Watering: Thoroughly water sod immediately after installation to wet the underside of the new sod pad and the soil immediately below to a depth of 6 inches. Maintain constant moisture for 2 weeks or until sod is fully rooted.
6. Top-Dress Fertilizer: Apply at the rate of (6) to (8) pounds per 1,000 square feet at 25 days and at 50 days after sodding.

3.5 MAINTENANCE OF NEW LAWNS

- A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.
- B. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing.

3.6 SATISFACTORY LAWN

- A. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from sidewalks and paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.

- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period until lawn is established.

END OF SECTION 32 92 00

Division 33 – Utilities

SECTION 33 10 00 - EXTERIOR WATER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.
- B. City of Hamlet standards and specifications (most recent edition).

1.2 SUMMARY

- A. This section includes water service piping, fire protection service mains and appurtenances from the source of water to a point 5 feet outside the building.

1.3 SUBMITTALS

- A. Product data for piping, valves, vaults, fire hydrants, and identification devices.

1.4 QUALITY ASSURANCE

- A. Comply with local utility department and fire department standards pertaining to materials, meter boxes, hose threads and installation.
- B. Comply with the requirements of the latest edition of the City of Hamlet standards and specifications.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Prepare materials for shipping and transport as follows:
 - 1. Ensure materials are dry and internally protected against rust and corrosion.
 - 2. Protect materials against damage to threaded ends, flange faces, pipe belts and spigots, and coatings.
 - 3. Set materials in best position for handling to prevent rattling.
- B. Storage: Use the following precautions for materials during storage:
 - 1. Do not remove end protectors unless necessary for inspection and reinstall for storage.
 - 2. Protect materials from weather, moisture and dirt. If outdoor storage is necessary, elevate and support materials off the ground or pavement in watertight enclosures.
 - 3. Store pipe in accordance with manufacturer's recommendations. Do not store plastic structures, pipe, and fittings in direct sunlight. Support materials to prevent sagging and bending.
- C. Handling: Handle materials on-site to prevent damage.

1. Handle materials to prevent interior and exterior coating and pipe-end damage, and to prevent the entrance of dirt, debris, and moisture.
2. Handle pre-cast concrete manholes and other structures according to manufacturer's written rigging instructions.
3. If any portion of piping and fittings is damaged, repairs should be made in accordance with manufacturer's recommendations prior to installation.

1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey to verify existing utility locations as needed. Verify that water distribution system piping may be installed in compliance with the design and referenced standards.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: The location of existing utilities, including underground utilities, is indicated on the drawings insofar as their existence and location were known at the time of preparation of the drawings. However, nothing in these Contract Documents shall be construed as a guarantee that such utilities are in the location indicated or that they actually exist or that other utilities are not within the area of operations. The Contractor shall make all necessary investigations to determine the existence and locations of such utilities far enough in advance of pipe laying to allow for adjustments due to conflicts in the horizontal and vertical positions of the pipeline.
 1. Do not proceed with utility interruptions without receiving Architect's written permission.
 2. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
 3. Do not interrupt existing utilities serving facilities occupied by others except when permitted by the utility owner and after arranging to provide acceptable temporary utility services.
 4. Existing utilities across or along the line of work are indicated only in an approximate location. Locate all underground lines and structures. Call "NC one call" at 1-800-632-4949 prior to construction. If utilities are marked that are not shown on the plans, locate utility vertically and horizontally and provide information to architect. The contractor shall pay for any damage to and for maintenance and protection of existing utilities and structures.
- D. Connections to Existing System:
 1. Before the start of the construction, the Contractor shall dig test pits on all crossings of and connections to the existing system, as applicable, to determine the existing system location, size, and piping material. If the location, size, and piping material differs from that shown on the Drawings, notify Engineer immediately.
 2. The Contractor shall make connections to the existing system under a pressure or non-pressure condition, as indicated, complying with the system owner's requirements for the time of day such work can be done. The Contractor shall pay all costs associated with the connections unless otherwise indicated. If the system owner performs the work, the Contractor shall arrange for the work to be done.
 3. Valves are to be operated only by the Owner.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with interior water piping and interior fire protection piping.

- B. Coordinate with other utility work.
- C. Do not interrupt utilities serving facilities occupied by Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide pipe materials and fittings compatible with each other. All materials shall comply with the requirements of the City of Hamlet Standards (latest Edition, Addenda, and approved materials list).

2.2 PIPE

A. Polyvinylchloride (PVC)

1. Schedule 40 Pipe shall meet the requirements of ASTM D 1785 and is permissible for water service piping up to and include 3 inches in diameter. Use PVC solvent cement conforming to ASTM D 2564 and tested and certified for contact with potable water in accordance with ANSI/NSF Standard No. 61.
2. Polyvinylchloride (PVC) for diameters of 4 inches and greater shall meet the requirements of AWWA C900, Table 2 (Cast Iron OD) Class 150 except that all connections shall be made using elastomeric gasket joints. Cell classification for the pipe shall be 12454-B. The water pipe shall also have certifications from FM (Factory Mutual), UL (Underwriters Laboratory), and NSF (National Sanitation Foundation).

B. Ductile Iron (DI)

1. Ductile iron pipe shall meet the requirements of AWWA C151 and AWWA C150. 3” through 12” pipe shall be, at a minimum, pressure class 350, and 14” through 20” pipe shall be, at a minimum, pressure class 250. 24-inch diameter pipe shall be a minimum pressure class 200. Pipe shall have cement-mortar lining and a bituminous seal coat conforming to the requirement of AWWA Standard C104.
2. Buried pipe shall have either mechanical joint or push-on joint conforming to the requirements of AWWA C111. Bolts for mechanical joints shall be high strength cast iron having an ultimate tensile strength of 75,000 psi and a minimum yield point of 45,000 psi.
3. Flanged joints for ductile iron pipe shall meet requirements of ANSI B 16.1.

C. Copper Tubing

1. Copper tubing shall meet requirements of ASTM B88 for Type “L” copper, hard drawn, for above ground and Type “K” hard drawn for below ground.

2.3 FITTINGS

A. Polyvinylchloride (PVC)

1. General
 - a. Fittings for water pipe up to and include 2 ½ inches in diameter shall be Schedule 40 PVC.

- b. All PVC Schedule 40 fittings shall be produced from PVC Type I cell classification 12454, conforming to ASTM D 1784. All injection molded PVC Schedule 40 fittings shall be certified for potable water service by NSF International and manufactured in strict compliance to ASTM D 2466.
- c. Use PVC solvent cement conforming to ASTM D 2564 and tested and certified for contact with potable water in accordance with ANSI/NSF Standard No. 61.

B. Ductile Iron (D1)

1. General

- a. Fittings for water pipe 3 inches in diameter and greater shall be ductile iron. Contractor shall use transition gaskets as necessary. Ductile iron fittings shall be in accordance with AWWA C110 or C153, latest edition. Pressure ratings shall be a minimum of 350 psi. All fittings shall be mechanical joint unless otherwise shown on the construction plans or approved by the Engineer.
- b. All fittings shall have a cement mortar lining with asphaltic seal coat on the interior and shall meet the requirements of the AWWA C104. Cement mortar lining shall be standard thickness.
- c. Exterior, asphaltic coating for ductile iron fittings shall meet requirements of AWWA C151 as applicable.

2. Mechanical Joints

- a. Mechanical joints and jointing materials shall meet requirements of AWWA C111.
- b. MEGALUGS, or approved equivalent, shall meet requirements of ASNI/AWWA C151/A21.51.

3. Flanged Joints

- a. Flanged joints shall meet requirements of ANSI B16.1 and AWWA C115.
- b. Flange joint gasket shall be full-face or ring type made of rubber and meeting the requirements of ANSI B16.21 and AWWA C115.

C. Copper

1. Fitting for copper piping shall meet requirements of ASNI B16.22 for wrought copper, sweat joint. Soldered joints shall be made using ASTM B32 Alloy Grade Sn96 or Sb5 solder having a maximum lead content of 0.2%.

2.4 VALVES

A. Gate Valves

1. Sizes Smaller than 2 inches

- a. Gate valves smaller than 2 inches shall be bronze, solid wedge, rising stem, with at least 200 psi operating pressure.

2. Sizes 2 inches Through 12 inches

- a. All gate valves shall be resilient seat gate valves. Resilient seat gate valves 2 inches through 12 inches in size shall comply with AWWA C-509 or AWWA C515, latest revision, and be UL listed, FM Approved, as well as certified by NSF to Standard 61.
- b. All buried valves shall be manually operated non-rising stem, equipped with a 2-inch square AWWA operating nut, for installation in a vertical position, unless

otherwise specified. All valves for underground vaults and above-ground service shall be manually operated outside stem and yoke (OS&Y).

- c. Valve ends shall be mechanical joint for buried underground service and flanged for underground vaults and above-ground service.
- d. The interior and exterior of the body and bonnet shall be coated with fusion bonded epoxy per ANSI/AWWA C550 Standard for Protective Interior Coatings for Valves and Hydrants.
- e. All internal parts shall be accessible without removing the body from the line.
- f. All valves shall open left (counter-clockwise).
- g. Valves shall be rated for 250 psi operating pressure and 500 psi test pressure.
- h. Valve stem extensions shall be required where the valve-operating nut is installed at a depth greater than four feet (4').

2.5 VALVE BOXES

- A. Valve boxes shall comply with AWWA M44 for cast-iron valve boxes. Materials shall include top section, adjustable extension (of length required for depth of burial of valve), cover (with lettering "WATER" cast or embossed on the cover), bottom section with base of size to fit over valve, and approximately 5-inch diameter barrel. All box assemblies shall have screw adjustment
- B. Valve boxes shall be firmly supported, centered and plumb over the operating unit of the valve. Box cover shall be set flush with the surface of finished pavement or at such other level as may be directed by the Architect. Valve rod extension with guide shall be required to maintain a distance of 2' – 4' from operating nut to top of box. The extension shall be provided with a 2-inch square operating not on top and a coupling to connect the extension to the operating nut on the valve. All valves shall be properly restrained.
- C. Extension pieces, if required, shall be cast iron or ductile iron. PVC pipe is not allowed for extensions.

2.6 FIRE HYDRANTS

- A. Fire hydrants shall be UL and FM approved, and shall also comply with the AWWA Fire Hydrant Specification C-502 (latest revision) and the following:
 1. Type: Compression - Dry Standpipe: Valve shall open against and close with the pressure. The design shall be such that all internal operating parts can be removed through the standpipe and main valve rod extended without excavating.
 2. Size: Internal valve diameter shall be a minimum 4-1/2".
 3. Inlet Size and Type: 6" mechanical joint end with accessories.
 4. Hose Nozzles: Each hydrant shall be equipped with two 2-1/2" I.D. hose nozzles matching local fire department hose threads (National Standard Threads) one quarter turn bayonet lock or threaded in with O-ring seal and suitable locking arrangement.
 5. Steamer Nozzle: Each hydrant shall be equipped with one 4-1/2" Steamer Nozzle matching local fire department hose threads (National Standard Threads) one quarter turn bayonet lock or threaded in with O-ring seal and suitable locking arrangement.
 6. Direction of Open: Left, counterclockwise.
 7. Size and Shape of Operating Nut and Cap Nuts: Nut and Cap Nuts shall be 1-1/2" point to flat pentagon. Each hydrant shall be equipped with a weather cap.
 8. Seal Plate: The hydrant shall be constructed with a moisture-proof lubricant chamber that encloses the operating threads, thereby automatically lubricating the threads each time the

hydrant is operated. The lubricant chamber shall be enclosed with at least three O-rings. The two lower O-rings will serve as pressure seals. The third O-ring will serve as a combined dirt and moisture seal to prevent foreign matter from entering the lubricant chamber. The hydrant shall be equipped with either an anti-friction washer or bronze bushing to reduce operating torque. The bonnet will be secured to the hydrant using bolts and nuts.

9. Standpipe - Groundline Safety Construction: The standpipe sections shall be connected at the groundline by a two-part, bolted safety flange or breakable lugs. The main valve rod sections shall be connected at the groundline by a frangible coupling. The standpipe and groundline safety construction shall be such that the hydrant nozzles can be rotated to any desired position without disassembling and removing the top operating components and the top section of the standpipe. The minimum inside diameter of the standpipe shall be 6".
10. Main Valve, Rod Assembly: The main valve rod assembly shall be constructed to allow removal of all operating parts through the standpipe regardless of depth of bury, using a removal wrench which does not extend below the groundline of the hydrant. The main valve seat ring shall be bronze, and its assembly into the hydrant shall involve bronze to bronze thread engagement, and the valve assembly pressure seals shall be obtained without the employment of torque compressed gaskets. The design of the main valve rod shall be such that operating threads at the top of the rod and the valve assembly threads at the bottom of the rod are isolated from contact with water in the standpipe or in the hydrant inlet shoe.
11. Drain Valve: The operation of the drain mechanism shall be correlated with the operation of the main valve and shall involve a momentary flushing of the drain ports each time the hydrant is opened. The drain ports shall be fully closed when the hydrant valve is more than 2-1/2 turns open and the drainage channel in the bronze valve seat ring shall connect to two or more outlet drain ports. No springs may be employed in the hydrant valve or drain valve mechanism.
12. Depth of Bury: Normally hydrants shall be suitable for installation in trenches 4-1/2' deep. Fire hydrants shall be adjusted to accommodate depths of bury greater than 4 1/2' deep and to meet actual field conditions. Adjustments shall be made per manufacturer's recommendations.
13. Painting Instruction: Two prime coats and one aluminum finish coat shall be used, unless otherwise specified. Exposed area of fire hydrant shall receive one field coat of aluminum after installation. The wetted surface of the hydrant shoe shall be epoxy coated to prevent corrosion of the waterway.
14. Pressure Rating: Test pressure 400 psi, working pressure 200 psi.

B. Approved Manufacturers include:

1. Mueller Centurion A-421
2. Kennedy 4-1/4" Figure K-81A
3. U.S. Pipe - Metropolitan 250
4. American Flow Control - Mark 73

2.7 FIRE DEPARTMENT CONNECTION

- A. Fire Department Connections: Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
 1. Standard: UL 405.

2. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.
3. Inlet Alignment: Inline, horizontal or Square.
4. Finish Including Sleeve: Polished bronze.
5. Escutcheon Plate Marking: "Fire Department Connection."
6. Per the City of Charlotte Fire Department requirements.

B. Approved Manufacturers include:

1. Potter Roemer, Model 5761 thru 5764
2. Guardian Fire Equipment, Inc., Models 6224 & 6226
3. Croker, 6000 Series

2.8 THRUST RESTRAINT

- A. Proved thrust restraint consisting of concrete blocking, bell restraint harness, retainer gland type or restrained joint type pipe at all changes in direction of pressure pipelines and as shown on construction drawings.
- B. Concrete thrust blocking units shall be as shown on the construction drawings or as directed by the inspector based upon field conditions. Concrete thrust blocking shall bear against undisturbed earth, and concrete shall have 3,000 psi strength at 28 days and shall meet requirements of ASTM C94.
- C. Where Lug Type retainer glands are used, installation must conform to the recommendations of the manufacturer before the pipe is backfilled and tested.

2.9 DETECTABLE MARKING TAPE

- A. Detectable marking tape shall be installed above all waterline pipe (including all service laterals).
- B. Plastic marking tape shall consist of one layer of aluminum foil laminated between two layers of inert plastic film. Tape shall be resistant to alkalis, acids and other destructive agents commonly found in the soil. The laminate shall be strong enough that the layers cannot be separated by hand.
- C. Tape shall be a minimum of 4-1/2 mils thick with a minimum tensile strength of 60 lbs. in the machine direction and 58 lbs. in the transverse direction per 3" wide strip. Tape color shall be APWA Color Coded for marking the particular utility line and shall be imprinted with a continuous warning message to indicate the type of utility being marked, the message normally being repeated every 16" to 36". Tape shall be inductively locatable and conductively traceable using a standard pipe and cable-locating device. Tape shall be 3" wide Terra Tape "Sentry Line Detectable 620," or approved equivalent.

2.10 TRACING WIRE

- A. Tracing Wire shall be installed on all non-metallic waterline (including all service laterals).
- B. Wire shall be No. 12, stranded, type THHN, thermoplastic insulated and nylon jacketed. Wire shall be color coded blue for water.
- C. Acceptable Wire Connectors:

1. Set screw pressure type for use with No. 12 stranded wire size. Holub Industries MA-2, Ideal Industries Model 30-222, or approved equal.
2. C-Tap for two way splicing of tracer wire, for use with No. 12 stranded wire size. T&B #54705 or approved equal.
3. Split bolts, three wire type for splicing of tracer wire, for use with No. 12 stranded wire size ILSCO Catalog #SEL-2S or approved equal.

D. Electric Tape – Vinyl electric tape.

E. Electrical Coating - Scotchkote 3M electrical coating Part No. 054007 or approved equal.

F. Wire nut – non-conductive for No. 12 stranded wire size.

2.11 TAPPING SLEEVE AND VALVES

A. Tapping Sleeves

1. Fabricated Steel
 - a. The body of the tapping sleeve shall be of 3/8" carbon steel, ASTM grade A285.
 - b. Flange to be AWWA C207 Class D ANSI, 150 lb. drilling.
 - c. The carbon steel body shall have a 12 mil thick coating of fusion-bonded epoxy. Bolts shall be 18-8, Type 304 stainless steel.
 - d. Gaskets shall be Grade 60 compounded for use with water, alkalies, mild acids and most hydro-carbon fluids, up to 212°F.
2. Stainless Steel
 - a. The body of the tapping sleeve shall be of 18-8 type 304 stainless steel.
 - b. Branch/flange to the ductile iron, carbon steel or 304 stainless steel, 150 lb. drilling.
 - c. MJ Gland shall be permanently affixed to the outlet branch and be 304 stainless steel.
 - d. Gaskets shall be Grade 60 compounded for use with water, alkalies, mild acids and most hydro-carbon fluids, up to 212° F.
 - e. Clamping hardware (nuts, bolts and washers) shall be 18-8 type 304 stainless steel, with plastic anti-gall washers. Drop-in bolts or welded-on studs are acceptable.
3. Fabricated Steel with Mechanical Joint Ends
 - a. Sleeve body, valve flange, gaskets, hardware and coating to be the same as the fabricated steel tapping sleeve.
 - b. The mechanical joint glands to be ASTMA-36 iron or ductile iron.
 - c. The gland retaining hardware (nuts, bolts and washers) to be 18-8 type 304 stainless steel.
4. Case Iron with Mechanical Joint Ends
 - a. The body and glands of the tapping sleeve shall be of ASTM-126, Class B cast or ductile iron. Sleeve shall be furnished complete with all mechanical joint accessories (bolts, nuts, gaskets and glands), and shall have a bituminous seal coating.
 - b. Valve flange, body gaskets and clamping hardware (bolts, nuts and washers) shall be as specified for the fabricated steel tapping sleeve.
5. Tapping Sleeve Applications

- a. The stainless steel, fabricated steel (with mechanical joint ends), or cast/ductile iron (with mechanical joint ends) tapping sleeves may be used for any approved tap on C-900 PVC or ductile iron water main.
- b. The stainless steel, fabricated steel (with mechanical joint ends), or cast/ductile iron (with mechanical joint ends) tapping sleeves may be used for all approved taps on asbestos-cement pipe (except 16" size) and for size-one size or one size down taps on all other pipe material.
- c. Due to the non-availability of the mechanical joint tapping sleeve for 16" asbestos-cement pipe, the stainless steel sleeve must be used for taps on this pipe.
- d. The fabricated steel tapping sleeve may be used for approved two (or more) size down taps on C-900 PVC, cast iron or ductile iron water main.
- e. Application Chart

Taps	Size on Size	Cast Iron, Asbestos Cement, Transite	PVC	Ductile Iron
Type	Stainless Steel	***Stainless Steel	Stainless Steel	Stainless Steel
of	Mechanical Joint	* Mechanical Joint	Mechanical Joint	Mechanical Joint
Sleeve			**Fabricated Steel	**Fabricated Steel

* Except on 16" A/C pipe

** Approved for use on 2 or more downsize taps only.

***Mueller H300 can not be used on A/C and C.I. pipe.

6. Certification, Testing and Installation

- a. The following testing and conditions relating to tapping sleeves apply to all manufacturers.
 - 1) The tapping sleeve shall be tested in place to a minimum of 200 psi.
 - 2) If the sleeve fails to the 200 psi pressure test, the original failed sleeve shall be replaced with an entirely new sleeve.
 - 3) The concrete thrust block shall be poured to also support the tapping sleeve from beneath. The tapping sleeve, valve and tapping machine assembly is to be adequately supported during the tapping operation to prevent movement or rotation of the tapping sleeve.
 - 4) Installation instruction must be followed in strict accordance with the manufacturer's recommendations.

B. Resilient Seated Tapping Valves

- 1. Tapping valves for diameters 2" through 12" shall meet the specifications as referenced in Section 2.4.A.2 except, the body seat rings shall have a clear inside opening sufficient to

- pass a cutter of full diameter and equal to the nominal size of the valve. The outlet end shall be suitable for use with the type of pipe specified.
2. Tapping valves will be suitable for use with all approved manufactured tapping sleeves without modification.
- C. Tapping-Sleeve Assemblies shall comply with MSS SP-60. Include sleeve and valve compatible with drilling machine.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of the exterior water system shall comply with the requirements of the latest edition of the City of Hamlet standards and specifications.
- B. Excavating and Backfilling
1. Contractor shall do all excavating of any and all materials encountered in the course of excavating for all underground utility systems. After the pipe is in place, backfill with suitable earth, free from rocks, organic material, etc.
 - a. Provide all necessary shoring required for the protection of excavations, existing utilities and workmen and do all necessary pumping required to keep excavation and pipe free of water from any source at all times.
 - b. Provide sufficient barricades, etc., adjacent to excavations to safeguard against injury to workmen and the public. Provide and maintain sufficient warning lanterns at walks, roadways, and parking areas to provide safety at all times.
 - c. Where roots of live trees are encountered in excavations, they shall be carefully protected during construction.
 - d. Exercise special care in backfilling trenches to guard against disturbing the joint.
 - e. Remove and dispose of any material not used for backfill.
 2. Removal of subsurface obstructions which are uncovered during excavation for installation of the water systems shall be removed by the Contractor at his expense. This shall include removal of existing concrete or brick of existing building foundations, footings, abandoned utility piping, wires, structures, rock boulders, etc., which may not be visible from surface investigations before construction, but will interfere with new installations. If such obstructions are encountered, they shall be removed two feet from around the area of new facility and backfilled with a suitable material as specified.
- C. Pipe Installation
1. Trenching, pipe laying, and backfilling shall be accomplished in a manner to prevent damage and mis-alignment of the pipe. Water mains shall be buried to a depth below the frostline or to a depth sufficient to provide a minimum of 30 inches cover, whichever is greater.
 2. Take precautions to ensure that pipe and related items are not damaged in unloading, handling and placing in trench. Examine each piece of material just prior to installation to determine that no damage has occurred. Remove any damaged material from the site and replace with undamaged materials.
 3. Keep pipe clean. Exercise care to keep foreign material and dirt from entering pipe during storage, handling and placing in trench. Plug or cap line at the end of each day.
 4. Do not lay pipe when weather or trench conditions are unsuitable.

5. Line and grade hubs shall be set by a registered surveyor at intervals to accurately insure proper location of water line and appurtenances. This shall include finished grade centerline stakes for fire hydrants, stakes at all fittings, referencing all property pins, etc. Cut sheets are required where the water line is to be laid to a grade according to the profiles in the plans, or where the future road grade is not yet to within 6" of its final location.
6. Water Pipe Laying
 - a. Laying of water pipe shall be accomplished only after the trench has been dewatered and the foundation and/or bedding has been prepared. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surfaces.
 - b. All pipe laid shall be retained in position so as to maintain alignment and joint closure until sufficient backfill has been completed to adequately hold the pipe in place. All pipe shall be laid to conform to the prescribed line and grade shown on the plans and shall include digging out for bell ends.
 - c. Water pipe runs intended to be laid straight shall be so laid. Deflection from a straight line may be made by deflecting the joints only when permission has been given by the Architect or Inspector. Joint deflection in pipe shall not exceed one-half that recommended by AWWA Standards or the manufacturer, whichever is less. Changes in grade or alignment which cannot be made by deflecting pipe joints shall be made by use of proper bends, offsets or special fittings as required.
 - d. The water pipe, unless otherwise approved by the Architect or Inspector, shall be laid upgrade from point of connection of the existing water line or form a designated starting point. Water pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with a water tight plug or cap. Plywood or plastic is not acceptable as a plug or cap.
 - e. The pipe shall be fitted and matched so that when laid in the work, units will form a smooth, uniform invert.
 - f. Prior to joining the pipe, all surfaces of the pipe to be joined and the surfaces of factory made jointing materials shall be clean and dry. Lubricants, primers, adhesives, etc., shall be applied and the pipes joined as recommended by the manufacturer's specifications. Sufficient pressure shall be applied in making the joint to assure that the pipe is "home". The interior of the pipe shall be cleaned all foreign material as the work progresses. At the end of the work day, the last pipe laid shall be blocked to prevent creep, and closed with a water tight plug or cap.
 - g. Joining pipe
 - 1) Ductile iron pipe to be joined as follows:
 - a) Mechanical joint pipe
 - i. Thoroughly clean inside of the bell and 8" of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating and other foreign matter from the joint. Paint the bell and spigot with soap solution (half cup granulated soap dissolved in 1 gallon water). Slip cast-iron gland on spigot end with lip extension of gland toward end of pipe. Paint rubber gasket with or dip into the soap solution and place on the spigot end with thick edge toward the gland. (Note: When installing PVC pipe into M.J. fittings, the beveled end of the pipe must be cut off).
 - ii. Push the spigot end forward to seat in the bell. Then carefully press the gasket into the bell so that it is located evenly around the joint. The gland is moved into position, bolts inserted and nuts turned finger tight. Tighten all nuts to torque listed below:

Bolt Size (inches)	Torque (ft – lbs)
5/8	40-60
3/4	60-90
1	70-100
1 – 1/4	90-120

- iii. Tighten nuts on alternate sides of the gland until pressure on the gland is equally distributed, and torque value is reached.
- iv. Permissible deflection in mechanical joint pipe shall not be greater than one-half of that listed in AWWA C600.
- b) Push-on joint ductile iron pipe
 - i. Thoroughly clean inside of the bell and 8” of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating, and other foreign matter. Flex rubber gasket and insert in the gasket recess of the bell socket. Apply a thin film of gasket lubricant supplied by pipe manufacturer, to the gasket and spigot end of the joining pipe.
 - ii. Insert spigot end of pipe into socket with care. The joint shall then be completed by forcing the plain end to the bottom of the socket with a forked tool or jack type device. Field cut pipe shall have the end filed to match the manufactured spigot end.
 - iii. Permissible deflection in push-on joint pipe shall not be greater than one-half of that listed in AWWA C600.
- 2) Polyvinyl chloride (PVC) pipe shall be joined in accordance with manufacturer’s recommendations.
- 3) Polyvinyl Chloride (PVC) Push-on Joint Pipe
 - a) Thoroughly clean inside of the bell and 1” beyond the reference mark on the spigot end of the joining pipe. Make certain the bell and rubber gasket have no foreign material that could interfere with the proper assembly of the pipe spigot.
 - b) Lubricate the gasket and spigot end of the pipe, using lubricant supplied by pipe manufacturer.
 - c) Insert the spigot end into the bell. Align the pipe sections and push the spigot end in until the reference mark on the spigot end is flush with the end of the bell. Use a bar and block of wood to push pipe home.
 - d) Field cut pipe shall be square cut and beveled to ensure proper assembly. Use a factory finished beveled end as a guide to produce an equivalent angle and length of taper.
- h. Tracing wire shall be accessible for test hook-up at all water meter boxes and test stations. The tracing wire must be continuous and completely insulated from ground. The tracing wire will be attached to the top of the pipe using duct tape at an interval no great than 16 feet. Tracing wire within test stations and meter boxes shall be stripped 3/4” from the end and capped with a wire nut to minimize electrical ground contact. Test stations shall be installed within 2 feet of all fire hydrants and

at intervals no greater than 1,000 feet. All connections at the main line must be electrically sound and physically secure with screw connections or clamps. All connections must be taped with electrical tape and sealed with an electrical coating sealant. Tracing wire for waterline shall be color coded blue.

- i. Place underground warning tape directly above all water mains 18" below finished grade.

D. Relation of Water Mains to Sewers

1. Lateral Separation of Sewers and Water Mains. Water mains shall be laid at least 10 feet laterally from existing or proposed sewers, unless local conditions or barriers prevent a 10-foot lateral separation in which case:
 - a. The water main is laid in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer; or
 - b. The water main is laid in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.
2. Crossing a Water Main Over a Sewer. Whenever it is necessary for a water main to cross over a sewer, the water main shall be laid at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer, unless local conditions or barriers prevent an 18 inch vertical separation in which case both the water main and sewer shall be constructed of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.
3. Crossing a Water Main Under a Sewer. Whenever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing.

E. Installation of Valves, Fittings, Hydrants and Fire Department Connection

1. General: Valves, fittings and hydrants shall be set and joined to the piping system as specified for cleaning, laying and joining pipe.
2. Valves and Valve Boxes: Cast iron valve boxes shall be firmly supported, centered and plumb over the operating unit of valve. Box cover shall be set flush with the surface of finished pavement or at such other level as may be directed by the Architect or Inspector. Valve rod extension with guide shall be required to maintain a maximum distance of 2'-4' from operating nut to top of box. All valves shall be properly restrained.
3. Cross Connections: Drainage branches or blow-offs shall not be connected to any sewer, submerged in any stream or installed in any manner which, in the opinion of the Architect or Inspector, will constitute a contamination or cross-connection hazard.
4. Hydrants
 - a. Connection to Main: Each hydrant shall be blocked and/or restrained and connected to the main as shown in the standard details. Each hydrant shall be provided with a minimum 6" diameter branch, controlled by an independent 6" resilient seat gate valve.
 - b. Setting of Hydrants: When hydrants are set, a drainage pit two feet in diameter and two feet below the bowl of the hydrant shall be excavated. The pit shall be filled with coarse gravel or #57 clean stone, mixed with coarse sand, to a level of 6" above the weephole. No hydrants drainage pit shall be well braced against unexcavated earth with suitable concrete blocking, and when directed shall be restrained to the pipe with approved harnessing.

- c. All hydrant valves shall be restrained with a hydrant tee.
- d. All hydrants shall be thoroughly cleaned of dirt or foreign matter before setting.
- 5. Fire Department Connection
 - a. Install ball drip valves at each check valve for fire department connection to mains.
 - b. Install protective pipe bollards on two sides of fire department connection, as deemed necessary.
- 6. Anchorage of Fittings: All fittings (i.e., each bend, tee, plug, valve and cap) shall be prevented from moving by means to adequate thrust reaction blocking and/or mechanical restrains, as shown in the standard details.

F. Installation of Fabricated Steel Tapping Sleeves

1. Clean pipe surface thoroughly, particular in the area where the gasket will seal. The Contractor shall wipe the pipe in the area where the tap is to be made with 1% chlorine solution prior to installing the sleeve.
2. Lubricate pipe and gasket with soap and water or gasket lubricating solution. Do not use grease or pipe lubricant. Under no condition shall antifreeze be used.
3. Mount body halves on pipe and ensure gasket is secure in gasket groove, and the tapping nipple is pointing in its final direction so it will not be moved or rotated on the pipe.
4. Insert bolts and hand tighten nuts, keeping equal gaps between body halves.
5. Prior to tightening nuts, position outlet as required to suite the installation. Ensure that test connection is accessible.
6. Tighten bolts, alternating from one side to the other to equalize the gap between halves. Continue to tighten bolts until sleeve halves conform to the contour of the pipe and all bolts are to a uniform tightness. The required torque for dry threads will be 70-100 ft. lbs. (Lubricated threads 35-50 ft. lbs). On thin wall or badly corroded pipe, care should be taken to prevent crushing or collapsing of the pipe.
7. A pressure test is required prior to tapping to test the sleeve and valve in place. Prior to pressure testing, the Inspector shall obtain a reading of line pressure in the system, either from a hydrant or a service. The pressure test should be at 2 ½ times line pressure or 200 psi, whichever is greater. The duration of this pressure test shall be a minimum of ten minutes. If the sleeve fails, the pressure test it shall be completely removed and returned and a new sleeve used. The tapping sleeve, valve and tapping machine assembly is to be adequately supported during the tapping operation to prevent movement or rotation of the tapping sleeve.
8. Proceed with tapping operation. Complete tapping procedure and perform the necessary checking as required and furnish the Inspector with the tap coupon.
9. Check the bolts for tightness and re-torque, if required.

3.2 FIELD QUALITY CONTROL

- A. Testing and Disinfection: Each properly isolated section of the piping system, including all water services, shall be subjected to a pressure test of 150 psi, or 1 ½ times the working pressure whichever is greater, measured at the high point of the system. Maintain this pressure for a minimum of two hours with an allowable leakage as follows:

WATER LINE TEST BASED ON 150 PSI		WATER LINE TEST BASED ON 150 PSI	
SIZE	MAX. ALLOWABLE LEAKAGE	SIZE	MAX. ALLOWABLE LEAKAGE

3/4"	.0138 (GAL/2 HRS)/100 L.F.	6"	.1103 (GAL/2 HRS)/100 L.F.
1"	.0184 (GAL/2 HRS)/100 L.F.	8"	.1471 (GAL/2 HRS)/100 L.F.
1 1/2"	.0276 (GAL/2 HRS)/100 L.F.	12"	.2207 (GAL/2 HRS)/100 L.F.
2"	.0368 (GAL/2 HRS)/100 L.F.	16"	.2942 (GAL/2 HRS)/100 L.F.
3"	.0552 (GAL/2 HRS)/100 L.F.	20"	.3678 (GAL/2 HRS)/100 L.F.
4"	.0736 (GAL/2 HRS)/100 L.F.	24"	.4413 (GAL/2 HRS)/100 L.F.

Prior to applying pressure to the lines, all reaction blocking, and/or mechanical restraints shall have been completed to the satisfaction of the Architect or Inspector. As the pipes are being filled, all air shall be expelled from the pipes by providing manual air relief valves at the high points of the system.

- B. Any defects discovered during this test shall be repaired and the test repeated until the results are satisfactory to the Architect or Inspector. Provide all equipment, materials and labor necessary to conduct the test. Provide a suitable test pump and properly calibrated gauge or other means for measuring leakage (such as a clean 50-gallon barrel with top cut out) which is satisfactory to the Architect or Inspector.
- C. Water used for flushing, sterilization and testing shall be furnished by the Contractor at his expense. Filling of water line may be performed after permission has been obtained from authority responsible for coordinating this activity. Contractor is not permitted to operate valves on existing lines.

4.1 DISINFECTION

- A. Prior to being placed in service, the pipe line and appurtenances shall be disinfected in general accordance with ANSI/AWWA C651, latest edition, "AWWA Standard for Disinfecting Water Mains". Supplemental procedures stipulated in the following sections compliment the AWWA C651 Standard, particularly with respect to flushing, testing, and tie-in to the existing water distribution system.
 - 1. Prevent contaminating materials from entering the water main during storage, construction, or repair.
 - 2. Remove, by flushing or other means, those materials that may have entered the water main.
 - 3. Chlorinate any residual contamination that may remain and flush the chlorinated water from the main.
 - 4. Protect the existing distribution system from backflow due to hydrostatic pressure test and disinfection procedures.
 - 5. Determine the bacteriological quality by laboratory test after disinfection.
 - 6. Make final connection of the approved new water main to the active distribution system.

B. Filling and Testing Procedures

1. Connection for the new water main to the existing distribution system for filling and testing shall be through a Contractor furnished flushing mechanism. The Contractor is to furnish the single gate valve, double check valve flushing assembly and all necessary fittings, reducers, increases and sleeves to make the piping connections. Assembly shall be approved by the responsible water authority prior to its use. A suitable valved piping arrangement for the addition of the water-chlorine solution is to be available on the new line side of the flushing assembly. The assembly is to be furnished with 125 psi rated flange connections and installed in a manner approved by the Inspector.

2. Initial Flushing

- a. The main shall be flushed prior to disinfection at a velocity of not less than 2.5 ft/s unless the responsible water authority determines that conditions will not permit the required flow. Adequate provision shall be made by the Contractor for disposals and neutralization of flushing water so that no physical or environmental damage results. Backflow prevention and initial flushing shall be in accordance with the

following table.

Main Size (Nominal)	Double Check Valve Single Gate Size	INITIAL FLUSH Min. Flow (gpm)
6"	4"	220
8"	4"	400
12"	6"	900
16"	6"	1500
20"	8"	2450
24"	10"	3525

- b. Since the large volume of water may have effects on the existing distribution system, the initial flushing is to be done only when the approval of and under the direction of the Construction Manager and/or Inspector. System demands may cause this flushing to be done at times when the existing distribution system demands are low.
 - c. Because of the large volume of water to be flushed from the fire hydrants or flushing hydrants, the Contractor must inspect the areas of discharge and provide the necessary equipment or materials to prevent any environmental damage or erosion. Sufficient hose length and termination fitting are to be provided so as to discharge the water into stable, heavily vegetated areas, drainage ponds, storm sewers, paved ditches, etc. The Contractor is to be responsible for any damage that may result from flushing.
3. Forms of Chlorine for Disinfection

It is the Contractor's responsibility to be familiar with and have available for his employees the "Product Data Safety Sheets" of any products used as a source of chlorine and to provide the proper safety instructions and personal protective equipment to the employees mixing and using materials for disinfection of the water facilities.

- a. Acceptable sources of chlorine for disinfection may be obtained from any of the following three sources:
 - 1) Liquid sodium hypochlorite (household bleach).
 - 2) Liquid sodium hypochlorite (industrial strength).
 - 3) Calcium hypochlorite granules.

Sources of chlorine shall be in conformance with AWWA B300 Standard for Hypochlorites, and NSF 60 and 61.

- b. The direct introduction of chlorine liquid from a pressure cylinder into a waterline is not safe and shall not be allowed.
 - c. The mixing of a source of chlorine to obtain a suitable disinfection solution shall be as follows:
 - 1) Liquid sodium hypochlorite is supplied in strengths from 5.25 percent available chlorine (commercially available household bleach) to 15 percent available chlorine (industrial strength sodium hypochlorite). A water-sodium hypochlorite solution shall be prepared by adding liquid sodium hypochlorite to water.
 - 2) A water calcium hypochlorite solution shall be prepared by dissolving calcium hypochlorite granules containing 65% available chlorine by weight in a pre-determined volume of water to make the desired water-calcium hypochlorite concentration. Disinfection of new mains by water calcium hypochlorite solution shall not be used unless a suction or in-line strainer is available on the solution pump to prevent any undissolved solids from entering the piping. An alternative method of straining the solution to remove undissolved granules may be approved by the Architect or Inspector on a case-by-case basis.
4. Method of Chlorine Application and Testing
- a. The continuous feed method of applying the disinfecting solution shall be as follows: Water from the existing distribution system or other approved sources of potable water supply shall flow through a flushing mechanism as indicated on the contract drawings at a constant, measured rate into the newly-laid pipeline. The water shall be mixed with a chlorine-water solution as prepared above, also fed at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration of the water and water/chlorine solution in the pipe is elevated to and maintained at, a minimum of 50mg/l available chlorine.
 - b. Since the forms of preparation for a water-sodium hypochlorite or water-calcium hypochlorite concentration are a batch process, a method acceptable to the Architect or Inspector shall be available to replenish the concentration being fed and mixed with the water flow, so there is no interruption of the flow of disinfection solution.
 - c. To assure that this concentration is maintained, the chlorine residual shall be measured at intervals not exceeding 2,000 feet and at the end of all branch lines or cul-de-sacs in accordance with procedures outline herein. During the application of the chlorine-water solution, valves, hydrants and any other appurtenances shall be operated in order to be thoroughly disinfected. Chlorine-water solution application shall continue until the entire new main is filled with water having a residual of a minimum of 50 mg/l chlorine solution. The chlorinated water shall be retained in the main for at least 24 hours. The free chlorine residual must be at least 10 mg/l after 24 hours in accordance with AWWA C651.
 - d. After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine residual of the water leaving the main is equal to the chlorine residual of the incoming system water. At that time, the new system

shall be valved off to allow the residual to dissipate to 0.2 mg/l before taking samples for bacteriological analysis.

5. Flushing

- a. Flush to remove disinfecting solution. This is a low velocity, low flow, flush through fire or flushing hydrants to remove the disinfecting solution from the new line. The use of a neutralizing chemical and piping arrangement is required. The expense of a neutralizing station is the responsibility of the Contractor.
- b. The final flush is a medium velocity, medium flow flush to clear the line of any chlorine solution used in the tie-in and to provide for fresh water throughout the new lines. Final flushing shall be in accordance with the following table.

Main Size (Nominal)	FINAL FLUSH Max. Flow (gpm)
6"	88
8"	160
12"	350
16"	624
20"	978
24"	1410

6. Bacteriological Tests

- a. Bacteriological samples will be taken in accordance with AWWA C651, Section 7.
- b. After final flushing, and before the water main is placed in service, samples shall be collected and tested for bacteriological quality. Two consecutive negative tests from the same location shall show the absence of coliform organisms. At least two samples shall be collected by the responsible water authority at least 24 hours apart at intervals determined by the Architect or Inspector (not exceed 2,000 feet apart and at the end of all branch lines) and tested by a qualified laboratory selected by the responsible water authority. The responsible water authority shall bill the Contractor a standard fee for this service including all retests.
- c. Samples for bacteriological analysis shall be collected in approved sterile bottles or bags treated with sodium thiosulfate. If laboratory results indicate the presence of coliform bacteria, the samples are unsatisfactory and disinfection shall be repeated as prescribed above until the samples are satisfactory. Cleaning, disinfection and testing shall be under the direction of the Architect or Inspector but remains the responsibility of the Contractor. The Contractor shall be responsible for any cost associated with the loading, hauling, discharging and dechlorination of the heavily chlorinated water.
- d. A sampling tap consisting of a corporation cock with metal pipe shall be installed within two feet of valves. The corporation stop inlet shall be male one inch in size and the outlet shall have one inch I.P. threads and a cap.
- e. After receiving satisfactory bacteriological test results, the Contractor shall coordinate with the Inspector the connecting of the new main to the existing system. All connecting pipe and fittings shall be clean and free of debris and shall be

swabbed or sprayed with a 1 percent sodium hypochlorite solution before they are installed.

END OF SECTION 33 10 00

SECTION 33 30 00 - SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the Contract Documents apply to the work of this Section.
- B. City of Hamlet standards and specifications.

1.2 SUMMARY

- A. This Section includes sanitary sewerage system piping and appurtenances from a point 5 feet outside the building to the point of disposal or to the connection point into the existing municipal wastewater system.

1.3 SUBMITTALS

- A. Product data for sewer piping specialties.
- B. Shop drawings for precast concrete sanitary manholes, including frames and covers.
- C. Shop drawings for cast-in-place concrete or field-erected masonry sanitary manholes, including frames and covers.
- D. Certification provided by the contractor that all materials and sewage piping have been tested and meet the provisions of the contract documents
- E. Inspection and test reports specified in the "Field Quality Control" Article.

1.4 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to sanitary sewerage systems, and to the requirements of the latest edition of the North Carolina Erosion and Sediment Control Planning and Design Manual for erosion control during installation.
- B. Utility Compliance: Comply with the requirements of City of Hamlet Standard Specifications (latest edition).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Prepare materials for shipping and transport as follows:
 - 1. Ensure materials are dry and internally protected against rust and corrosion.
 - 2. Protect materials against damage to threaded ends, flange faces, pipe bells and spigots, and coatings.

3. Set materials in best position for handling to prevent rattling.
- B. Storage: Use the following precautions for materials during storage:
1. Do not remove end protectors unless necessary for inspection and reinstall for storage.
 2. Protect materials from weather, moisture and dirt. If outdoor storage is necessary, elevate and support materials off the ground or pavement in watertight enclosures.
 3. Store pipe in accordance with manufacturer's recommendations. Do not store plastic structures, pipe, and fittings in direct sunlight. Support materials to prevent sagging and bending.
- C. Handling: Handle materials on-site to prevent damage.
1. Handle materials to prevent interior and exterior coating and pipe-end damage, and to prevent the entrance of dirt, debris, and moisture.
 2. Handle pre-cast concrete manholes and other structures according to manufacturer's written rigging instructions.
 3. If any portion of piping and fittings is damaged, repairs should be made in accordance with manufacturer's recommendations prior to installation.

1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey to verify existing utility locations. Verify that sanitary sewerage system piping may be installed in compliance with the design and referenced standards.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: The location of existing utilities, including underground utilities, is indicated on the drawings insofar as their existence and location were known at the time of preparation of the drawings. However, nothing in these Contract Documents shall be construed as a guarantee that such utilities are in the location indicated or that they actually exist or that other utilities are not within the area of operations. The Contractor shall make all necessary investigations to determine the existence and locations of such utilities far enough in advance of pipe laying to allow for adjustments due to conflicts in the horizontal and vertical positions of the pipeline.
1. Do not proceed with utility interruptions without receiving Architect's written permission.
 2. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
 3. Do not interrupt existing utilities serving facilities occupied by others except when permitted by the utility owner and after arranging to provide acceptable temporary utility services.
 4. Existing utilities across or along the line of work are indicated only in an approximate location. Locate all underground lines and structures. Call "NC one call" at 1-800-632-4949 prior to construction. If utilities are marked that are not shown on the plans, locate utility vertically and horizontally and provide information to architect. The contractor shall pay for any damage to and for maintenance and protection of existing utilities and structures.
- D. Connections to Existing System:
1. Before the start of the construction, the Contractor shall dig test pits on all crossings of and connections to the existing system, as applicable, to determine the existing system location, size, and piping material. If the location, size, and piping material differs from that shown on the Drawings, notify Engineer immediately.

2. The Contractor shall make connections to the existing system under a pressure or non-pressure condition, as indicated, complying with the system owner's requirements for the time of day such work can be done. The Contractor shall pay all costs associated with the connections unless otherwise indicated. If the system owner performs the work, the Contractor shall arrange for the work to be done.
3. Valves are to be operated only by the Owner.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with interior building sanitary drainage piping.
- B. Coordinate with other utility work.
- C. Do not interrupt utilities serving facilities occupied by the Owner.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE LINING

- A. General: Provide pipe materials and fittings compatible with each other.
- B. Gravity Sewer Pipe:
 1. Polyvinylchloride (PVC) Sewer:
 - a. Polyvinylchloride (PVC) non-pressure pipe (4"-15") shall meet requirements of ASTM D3034, Type PSM, SDR-35 with elastomeric gasket joints meeting requirements of ASTM D3212. Bedding shall be as shown on the construction plans.
 2. Ductile Iron (DI) Sewer:
 - a. Ductile iron (DI) non-pressure pipe shall meet requirements of AWWA C151. Pipe shall be thickness Class 52. Pipe shall have cement-mortar lining and a bituminous seal coat. Thickness classes shall meet requirement of AWWA C150.
 - b. Mechanical joints and jointing material shall meet requirements of AWWA/ANSI C111/A21.11.
 - c. Flanged joints for ductile iron pipe shall meet requirements of ANSI B16.1. Flanged joint gaskets shall be full face, made of 1/16-inch thick rubber, and shall meet the requirements of ANSI B16.21.
 - d. Push on joint and rubber gasket shall meet requirements of AWWA C111.
 - e. Cement mortar lining with bituminous seal coat for ductile iron pipe and fittings shall meet requirements of AWWA/ANSI C104/A21.4.
 - f. Cement mortar lining shall be standard thickness.
 - g. Exterior, bituminous coating for ductile iron pipe shall meet requirements of AWWA/ANSI C106/A21.6 or AWWA/ANSI C151/A21.51 as applicable.

2.2 FITTINGS

- A. General: Provide pipe fitting materials compatible with each other.

B. Polyvinylchloride (PVC) Gravity Sewer:

1. Polyvinylchloride (PVC) non-pressure fittings (4"-15") shall meet requirements of ASTM D3034, Type PSM, SDR-35 with elastomeric gasket joints meeting requirements of ASTM D3212.

C. Ductile Iron (DI) Gravity Sewer:

1. Fittings shall be ductile iron. Ductile iron fittings shall meet requirements of AWWA C110. Pressure ratings shall be a minimum of 350 psi for all fittings. Fittings shall have cement-mortar lining and a bituminous seal coat.
2. Gaskets: ASTM F 477, elastomeric seal.
3. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, for push-on joints.
4. Compact-Pattern, Ductile-Iron Fittings: AWWA C153, for push-on joints.
5. Fitting Interior Coating: AWWA C104, asphaltic-material seal coat, minimum 1-mil (0.025-mm) thickness.
6. Mechanical joints and jointing materials shall meet requirements of AWWA C111.
 - a. Mechanical joint retainer glands shall meet requirements of AWWA C111. Retainer gland shall be fitted with setscrews.
 - b. Metal harness shall be galvanized rods and clamps as detailed on Drawings.
 - c. Provide systems called for (or equals) as required on the drawings for restrained joints on aerial pipe.

D. Sewer Saddles:

1. Applies to taps for service lines of 4 inches or 6 inches on main line pipe up to 12 inches.
2. Straps shall be stainless steel, 24-gauge, 2.5 inches wide
3. Nuts and bolts shall be stainless steel, 3/8-inch diameter.
4. Saddle shall be coated cast iron, with tubular rubber gasket.
5. Adapter compatible with service line shall be secured to saddle with PVC sleeve.
6. Sewer saddles shall be as manufactured by one of the following:
 - a. ROMAC Industries, Inc
 - b. GENCO (The General Engineering Co.)
 - c. Inserta Fittings Company

2.3 MANHOLES

A. General

1. Manholes shall be constructed of pre-cast reinforced concrete manhole sections in accordance with the requirements of ASTM C478 and detailed on the construction plans.
2. A maximum of two lift holes per manhole section may be provided.
3. Provide tongue and groove joints in manhole sections with a preformed groove in the tongue for placement of an O-ring type round, rubber gasket, or Press Seal, Inc.'s Profile RS gasket.
 - a. Gasket shall comply with requirements of ASTM C443.
 - b. Gasket shall seal the joint from either internal or external hydrostatic pressure.

B. Flexible Pipe Connectors: Provide flexible pipe connections to manholes, other than acid-resistant manholes, for pipes 24 inches and smaller in size.

1. Materials shall be resistant to water, sewage, acids, ozone, weathering and aging. Connectors shall conform to the requirements of ASTM C923. Use neoprene conforming to ASTM C443 and stainless steel, Series 300.
 2. Cast or core drill openings in manholes to receive connectors. Connectors shall be suitable for field repair or replacement. Connectors not suitable for field replacement are unacceptable.
 3. The assembled connectors shall allow at least an 11° angular deflection of the pipe and at least one inch of lateral misalignment in any direction and be suitable for a normal variation in diameter or roundness for the pipe material used.
 4. Connectors shall be similar to Kor-N-Seal as manufactured by NPC, Inc.
- C. Frames and Covers: Manhole frames and covers shall be molded of gray cast iron conforming to ASTM A48, Class 30. Castings shall be coated with a coal tar pitch varnish, to which sufficient oil has been added to make a smooth coating that is not tacky or brittle. Seating surfaces between frame and cover shall be machined. Manhole frame and covers shall be one of the following, or equivalent:
1. Street Type
 - a. Neenah Foundry
 - b. Capitol Foundry
 - c. Sigma Corporation
 - d. East Jordan Iron Works
 2. Watertight
 - a. Capitol Foundry
 - b. East Jordan Iron Works
 3. Vandal Proof
 - a. Neenah Foundry
 - b. Capitol Foundry
- D. Adjusting Rings: Adjusting rings shall be made of reinforced concrete or HDPE (as manufactured by LadTech, Inc.). Brick, block and mortar construction shall not be permitted in lieu of rings. Rings shall be of required thickness to obtain the desired top elevation and match the diameter of the frame and cover. Any combination of adjustment rings shall not exceed a total thickness of 9 inches.
- E. Entry Seals: Entry seals shall be furnished on all sanitary sewer manholes. Entry seals may be installed on the interior of the manhole using Cretex Specialty Products' "Chimney Seal" or on the exterior of the manhole using Canosa's "Wrapid Seal," or approved equivalents.
- F. Vent Piping: Vent piping shall be installed in accordance with the details shown on the construction drawings.
- G. Frame-to-Manhole Sealant: Sealant for manhole frames shall be a one-component polyurethane sealant similar to Sika "Sikaflex" Type 1a.
- H. Steps: Manhole steps shall be corrosion-resistant and shall be one-half inch grade 60 steel reinforcing rod encapsulated in a copolymer polypropylene. The steps shall conform with ASTM C478 paragraph 11 and to the dimensions shown on the Standard Details.
- I. Exterior Coating: Exterior of manhole to be coated with bitumastic waterproofing.

J. Interior Product Linings and Coatings

1. Interior protective linings and coatings shall provide resistance to deterioration due to hydrogen sulfide (H₂S) and by-products thereof. Selected system of liners, coatings or admixture shall include provisions to protect concrete and all discontinuities including precast joints, pipe penetrations, seams, and entryways.
2. Liners: Liners for acid-resistant manholes shall be of High Density polyethylene (HDPE), Polypropylene Random Copolymer (PP-R) or polyvinylchloride (PVC) construction and shall be installed to protect the pre-cast manhole sections from the inside base of the manhole to the base of the manhole cover frame. Benches and inverts for lined manholes shall be coated as specified for coated manholes.
 - a. HDPE or PP-R liners shall consist of a 2mm thick HDPE (high density polyethylene) or Polypropylene Random copolymer (PP-R) with a large number of anchoring studs (a minimum of 420/m², 39/ft²), manufactured during the extrusion process in one piece with the sheet so there is no welding and no mechanical finishing work to attach the studs to the sheet. Liner shall be similar to AGRU Sure Grip®. Joints between sections of the liner shall be sealed in accordance with the manufacturer's instructions.
 - b. PVC liners shall consist of polyvinylchloride plates, not less than 0.060 in. thick, with integral bonding ribs and shall be similar to Amercoat "T-Lock Amer-Plate." Joints between sections of liner shall be welded in accordance with the manufacturer's instructions.
3. Coatings: Coatings for proposed and existing manholes shall be Raven Lining System epoxy coatings or approved equivalent.
4. Admixtures: Admixtures for use in concrete manholes shall be ConShield™ or approved equivalent.

2.4 CLEANOUTS

- A. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame heavy-duty, secured, scoriated cast-iron cover.
- B. Sewer pipe fitting and riser to cleanout shall be the same material as the run of pipe for which it serves.

2.5 Detectable Marking Tape

- A. Detectable marking tape shall be installed above all gravity sewer (including all service laterals).
- B. Plastic marking tape shall consist of one layer of aluminum foil laminated between two layers of inert plastic film. Tape shall be resistant to alkalis, acids and other destructive agents commonly found in the soil. The laminate shall be strong enough that the layers cannot be separated by hand.
- C. Tape shall be a minimum of 4-1/2 mils thick with a minimum tensile strength of 60 lbs. in the machine direction and 58 lbs. in the transverse direction per 3" wide strip. Tape color shall be APWA Color Coded for marking the particular utility line and shall be imprinted with a continuous warning message to indicate the type of utility being marked, the message normally being repeated every 16" to 36". Tape shall be inductively locatable and conductively traceable

using a standard pipe and cable-locating device. Tape shall be 3" wide Terra Tape "Sentry Line Detectable 620," or approved equivalent.

PART 3 – EXECUTION

3.1 GENERAL

- A. Installment of all sewer features shall conform to the latest requirements of the City of Hamlet.
- B. Follow State Health Department Standards for the separation of sanitary sewer and water distribution systems.
- C. Parallel Installation
 - 1. Normal Conditions - Sewer lines and manholes shall be constructed at least 10 feet horizontally from a waterline whenever possible. The distance shall be measured edge-to-edge.
 - 2. Unusual Conditions - When local conditions prevent a horizontal separation of at least 10 feet, then maximum horizontal separation shall be provided with vertical separation of bottom of waterline at least 18 inches above top of sewer. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe pressure-tested in place to 5 psi without leakage prior to backfilling. The sewer manhole shall be of watertight construction and tested in place.
- D. Crossing:
 - 1. Normal Conditions - Sewers crossing under waterlines shall be laid to provide a separation of at least 18 inches between the bottom of the waterline and the top of the sewer whenever possible.
 - 2. Unusual Conditions - When local conditions prevent a vertical separation described in Crossing, Normal Conditions, paragraph above, the following construction shall be used:
 - a. Sewers passing over or under waterlines shall be constructed of ductile iron pipe with mechanical joints as described in Parallel Installation, Unusual Conditions above.
 - b. Sewers passing over waterlines shall be laid to provide:
 - 1) Adequate structural support for the sewers to prevent excessive deflection of the joints and settling on and breaking waterline.
 - 2) Maximum separation of water and sewer line joints.
- E. Sanitary and/or combined sewers or sewer manholes - No water pipes shall pass through or come in contact with any part of a sewer or sewer manhole

3.2 EXCAVATING AND BACKFILLING

- A. Excavation, trenching, backfilling and bedding for all piping specified herein shall conform to the applicable requirements of the NCDOT Standard Specifications for Roads and Structures and/or to details shown on the construction plans.
- B. Remove any and all materials encountered in the course of excavating for all underground utility systems. After the pipe is in place, backfill with suitable material, free from frozen earth, rocks, and organic materials.

1. Provide all necessary shoring required for the protection of excavations, existing utilities and workmen and do all necessary pumping required to keep excavation and pipe free from water from any source at all times.
 2. Provide sufficient barricades adjacent to excavations to safeguard against injury to workmen and the public. Provide and maintain sufficient warning lanterns at walks, roadways, and parking areas to provide safety at all times.
 3. Where roots of live trees are encountered in excavations, they shall be carefully protected during construction.
 4. Exercise special care in backfilling trenches to guard against disturbing the joints.
 5. Remove and dispose of any material not used for backfill.
- C. Removal of subsurface obstructions which are uncovered during excavation for installation of the sanitary sewer systems shall be by the Contractor at his expense. This shall include removal of existing concrete or brick from existing building foundations, footings, abandoned utility piping, wires, structures, rock boulders, etc., which may not be visible from surface investigations before construction, but will interfere with new installations. If such obstructions are encountered, they shall be removed two feet from around the area of new work and the excavation backfilled with a suitable material as specified.

3.3. PIPE HANDLING

- A. Take all precautions to ensure that pipe, fittings, and related items are not damaged in unloading, handling and placing in trench. Examine each piece of material just prior to installations to determine that no damage has occurred. Remove any damaged material from the site and replace with undamaged material.
- B. Keep pipe clean. Exercise care to keep foreign material and dirt from entering pipe during storage, handling and placing in trench. Close ends of in-place pipe at the end of any work period to prevent entry of animals and foreign material.
- C. Survey Line and Grade
 1. Line and grade hubs shall be set by a registered surveyor, maintained by the Contractor, and the Architect provided with cut-sheets.
 2. Contractor shall have level or transit in good working order on the job set up at all times to periodically check line and grade of pipe.

3.4. GRAVITY SEWER PIPE LAYING

- A. Laying of sewer pipe shall be accomplished to line and grade as indicated on the contract drawings and in the trench only after it has been dewatered and the foundation and/or bedding has been prepared. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surfaces. Do not lay pipe when weather or trench conditions are unsuitable.
- B. Pipe and fittings shall be strung out along the route of construction with the bells facing in the direction in which the work is to proceed. Pipe shall be placed where it will cause the least interference with traffic. Laying of the pipe shall be commenced immediately after the excavation is started and every means must be used to keep pipe laying closely behind the trenching. The Engineer may stop the trenching when, in his opinion, the trench is open too far in advance of the pipe laying operation. The bottom of the sewer trench shall be shaped to give substantially

uniform circumferential support to the lower on-third of each pipe. Holes shall be scooped out where the bells occur leaving the entire barrel of the pipe bearing on the pipe bed.

- C. All pipe laid shall be retained in position so as to maintain alignment and joint closure until sufficient backfill has been completed to adequately hold the pipe in place. All pipe shall be laid to conform to the prescribed line and grade shown on the contract drawings. After completion the pipe shall exhibit a full circle of light at one manhole when viewed from the next.
- D. The sewer pipe shall be laid upgrade from point of connection to the existing sewer or from a designated starting point. If the starting point is at an existing stub, it shall be removed and a full length of pipe installed. The sewer pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with a water tight plug or cap. When the upstream end of a sewer does not terminate at a manhole, it shall be plugged and its location marked in a manner approved by the Inspector.
- E. The pipe shall be fitted and matched so that when installed it will form a smooth, uniform invert.
- F. Prior to joining the pipe, all surfaces of the pipe to be joined and the surfaces of factory-made jointing materials shall be clean and dry. Lubricants, primers, adhesives, etc., shall be applied and the pipes joined as recommended by the manufacturer's specifications. Sufficient pressure shall be applied in making the joint to assure that the pipe is "home". The interior of the pipe shall be cleaned of all foreign material as the work progresses. At the end of the work day, the last pipe laid shall be blocked to prevent creep, and closed with a water tight plug or cap.
- G. Joining Pipe
 - 1. Ductile iron pipe is to be joined in accordance with the requirements of AWWA Standard C600 and the manufacturer's recommendations.
 - 2. Polyvinyl chloride (PVC) pipe shall be joined in accordance with ASTM Standard D-2321.
 - 3. Other type pipe shall be joined in accordance with the manufacturer's recommendations and the requirements of the County approved plans and specifications.
- H. All visible leaks shall be corrected prior to testing.

3.5. DETECTABLE MARKING TAPE

- A. Install detectable marking tape in all trenches containing buried, non-metallic, pipelines. Tape shall be installed in all trenches with a cover of 18" to 54" and a minimum clearance over the pipelines of 18". Tape shall be made electrically conductive throughout the entire system through the use of splices of a type recommended by the manufacturer.

3.6. CLEAN UP

- A. Upon the completion of the installation of the sanitary sewer system and prior to acceptance, sediment and debris shall be removed from the limits of construction. All trash and debris shall be removed and properly disposed of. Areas not otherwise stabilized shall be seeded and mulched and a good stand of grass established.

3.7. FIELD QUALITY CONTROL

- A. Clean, inspect, and test in accordance with the latest requirements of the City of Hamlet.

PART 4 -TESTING

A. Gravity Sewers

1. All testing shall be in accordance with NCDENR standards.
2. Testing of gravity sewer lines shall be conducted on short sections of sewer line, i.e., between manholes. Provide all labor, materials, tools, and equipment necessary to make the tests, and ensure that zero infiltration is provided. All equipment and methods used shall be acceptable to the Engineer and the Owner. All monitoring gages shall be subject to calibration, if deemed necessary.
3. Deflection tests shall be performed on all pipe installations. The test shall be conducted after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system. As an alternative to waiting 30 days to permit stabilization of the soil-pipe system, the Division will accept certification from a soil testing firm verifying that the backfill of the trench has been compacted to at least 95% maximum density.
4. No pipe shall exceed a deflection of 5 percent. If deflection exceeds 5 percent, replacement or correction shall be accomplished in accordance with requirements in the approved specifications.
5. The rigid ball or mandrel used for the deflection test shall have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM Specification, to which the pipe is manufactured. The pipe shall be measured in compliance with ASTM D 2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The test shall be performed without mechanical pulling devices.
6. Sanitary sewer lines 24 in. diameter and smaller shall be tested after backfill using a low-pressure air test in accordance with ASTM C924.
7. Summary of Method: Plug the section of the sewer line to be tested. One of the plugs used at the manhole must be tapped and equipped for the air inlet connection for filling the line from the air compressor. Introduce low-pressure air into the plugged line. Use the quantity and rate of air loss to determine the acceptability of the section being tested.
8. Preparation of the sewer line: Flush and clean the sewer line prior to testing, thus serving to wet the pipe surface as well as clean out any debris. A wetted interior pipe surface will produce more consistent results. Plug all pipe outlets using approved pneumatic plugs with a sealing length equal to or greater than the diameter of the line being tested to resist the test pressure. Give special attention to laterals.
9. Groundwater Determination: Install a ½-inch capped galvanized pipe nipple, approximately 12 inches long, through the manhole on top of the lowest sewer line in the manhole. Immediately prior to the line acceptance test, the ground water elevation shall be determined by removing the pipe cap and blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic hose to the pipe nipple. The hose shall be held vertically and a measurement of the height in feet of water over the invert of the pipe shall be taken after the water has stopped rising in the plastic hose.
10. Procedures: Determine the test duration for the section under test by computation from the applicable formulas shown in ASTM C828. The pressure-holding time is based on an average holding pressure of 3 psi gage or a drop from 3.5 psi to 2.5 psi gage.
 - a. Add air until the internal air pressure of the sewer line is raised to approximately 4.0 psi gage. After an internal pressure of approximately 4.0 psig is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test section stabilizes.
 - b. When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi gage, commence the test. Before starting the test, the pressure may be allowed

- to drop to 3.5 psig. Record the drop in pressure for the test period. If the pressure has dropped more than 0.5 psi gage during the test period, the line shall be presumed to have failed. The test may be discontinued when the prescribed test time has been completed even though the 0.5 psig drop has not occurred.
- c. The test procedure may be used as a presumptive test, which enables the installer to determine the acceptability of the line prior to backfill and subsequent construction activities.
 - d. If the pipe to be tested is submerged in ground water, the test pressure shall be increased to 1.0 psi for every 2.31 feet the ground water level is above the invert of the sewer.
11. Safety: The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared.
- a. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. In as much as a force of 250 lbs. is exerted on an 8 inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.
 - b. As a safety precaution, pressurized equipment shall include a regulator or relief valve set at perhaps 10 psi to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

END OF SECTION 33 30 00

FORM OF PROPOSAL

Hendrick Center for Automotive Training

Contract:

Richmond Community College

Bidder:

SCO ID #22-25472-02A

Date:

The undersigned, as bidder, hereby declares that the only person or persons interested in this proposal as principal or principals is or are named herein and that no other person than herein mentioned has any interest in this proposal or in the contract to be entered into; that this proposal is made without connection with any other person, company or parties making a bid or proposal; and that it is in all respects fair and in good faith without collusion or fraud. The bidder further declares that he has examined the site of the work and the contract documents relative thereto, and has read all special provisions furnished prior to the opening of bids; that he has satisfied himself relative to the work to be performed. The bidder further declares that he and his subcontractors have fully complied with NCGS 64, Article 2 in regards to E-Verification as required by Section 2.(c) of Session Law 2013-418, codified as N.C. Gen. Stat. § 143-129(j).

The Bidder proposes and agrees if this proposal is accepted to contract with the

Trustees of Richmond Community College

in the form of contract specified below, to furnish all necessary materials, equipment, machinery, tools, apparatus, means of transportation and labor necessary to complete the construction of

Hendrick Center for Automotive Training

in full in complete accordance with the plans, specifications and contract documents, to the full and entire satisfaction of the State of North Carolina, and the

Richmond Community College

Designer: ADW Architects

with a definite understanding that no money will be allowed for extra work except as set forth in the General Conditions and the contract documents, for the sum of:

SINGLE PRIME CONTRACT:

Base Bid:

_____ Dollars(\$)

General Subcontractor:

_____ Lic _____

Plumbing Subcontractor:

_____ Lic _____

Mechanical Subcontractor:

_____ Lic _____

Electrical Subcontractor:

_____ Lic _____

GS143-128(d) requires all single prime bidders to identify their subcontractors for the above subdivisions of work. A contractor whose bid is accepted shall not substitute any person as subcontractor in the place of the subcontractor listed in the original bid, except (i) if the listed subcontractor's bid is later determined by the contractor to be non-responsible or non-responsive or the listed subcontractor refuses to enter

into a contract for the complete performance of the bid work, or (ii) with the approval of the awarding authority for good cause shown by the contractor.

ALTERNATES:

Should any of the alternates as described in the contract documents be accepted, the amount written below shall be the amount to be "added to" or "deducted from" the base bid. (Strike out "Add" or "Deduct" as appropriate.)

GENERAL CONTRACT:

Alternate No. 1:

(Add) (Deduct) Provide Schlage Everest keying system. See Specification Section 08 71 00.

Dollars(\$)

Alternate No. 2:

(Add) (Deduct) Provide BACnet DDC system from Alerton. See Specification 23 09 00 Direct Digital Control System.

Dollars(\$)

Alternate No. 3:

(Add) (Deduct) Provide modified bitumen roofing, as manufactured by SOPREMA. See Specification 07 51 00.

Dollars(\$)

Alternate No. 4:

(Add) (Deduct) Provide masonry/metal screen wall in lieu of fixed louver screen. See Sheet A900.

Dollars(\$)

UNIT PRICES

Unit prices quoted and accepted shall apply throughout the life of the contract, except as otherwise specifically noted. Unit prices shall be applied, as appropriate, to compute the total value of changes in the base bid quantity of the work all in accordance with the contract documents.

Unit Price No. 1: Unsuitable Soil Removal & In-Place Structural Fill Unit Price (\$) _____ per cubic yard

1. Removal and off-site disposal of unsuitable soil. Measurement shall be by cross section of excavation of the work area (not borrow area). Unit price shall include removal, transportation, on-site disposal, and replacement with suitable fill material.
2. Unit of Measurement: Cubic Yard.
3. Contractor shall include in the Base Bid **2,500 cubic yards** of unsuitable soil removal. Unit price shall be utilized to make adjustments in actual quantities encountered. Unit price shall include replacement with suitable fill.

Unit Price No. 2: Import Fill Unit Price (\$) _____ per cubic yard

1. Import suitable fill material as required for grading the site as shown in the Civil drawings. Unit price shall include transportation, and import of suitable fill material.
2. Unit of Measurement: Cubic Yard.
3. Contractor shall include in the Base Bid **3,500 cubic yards** of import fill. Unit price shall be utilized to make adjustments in actual quantities encountered. Unit price shall include import, placement, and grading of suitable fill material.

Unit Price No. 3: Removal of Trench Rock Unit Price (\$) _____ per cubic yard

1. Removal and off-site disposal of Trench Rock. Measurement shall be by cross section of excavation. Unit price shall include removal, transportation, off-site disposal, and replacement with suitable fill material.
2. Unit of Measurement: Cubic Yard.

Unit Price No. 4: Removal of Mass Rock Unit Price (\$) _____ per cubic yard

1. Removal and on-site disposal of Mass Rock. Measurement shall be by cross section of excavation. Unit prices shall include removal, transportation, off-site disposal and replacement with suitable fill material.
2. Unit of Measurement: Cubic Yard.

Unit Price No. 5: In-Place Concrete Sidewalk Unit Price (\$) _____ per square foot

1. Concrete sidewalk. Unit prices shall include removal, transportation, and off-site disposal costs of existing concrete, and replacement with new concrete.
2. Unit of Measurement: Square Foot (4" thickness)

Unit Price No. 6: Standard Duty Asphalt Paving Unit Price (\$) _____ per square yard

1. Description: Standard Duty Asphalt paving - 6" compacted ABC stone with 2" of SF9.5B surface course. Cost should include removal and off-site disposal of existing asphalt pavement and sub-base totaling 8" so the proposed asphalt surface is flush with the surrounding existing surface, including procedures for measurement and payment, according to Division 32.
2. Unit of Measurement: Square Yard.

Unit Price No. 7: Heavy Duty Asphalt Paving Unit Price (\$) _____ per square yard

1. Description: Heavy Duty Asphalt paving - 8 1/2" compacted ABC stone with 2 1/2" of I-19B intermediate course and 1 1/2" of SF9.5B surface course. Cost should include removal and off-site disposal of existing asphalt pavement and sub-base totaling 12 1/2" so the proposed asphalt surface is flush with the existing surface, including procedures for measurement and payment, according to Division 32.
2. Unit of Measurement: Square Yard.

- Unit Price No. 8:** 2000 Psi Lean Concrete Fill for Footings Unit Price (\$)_____per cubic yard
1. Description: 2000 psi lean concrete fill for footings, including procedures for measurement and payment, according to Division 03.
 2. Unit of Measurement: Cubic Yard.

- Unit Price No. 9:** Irrigation Lines Unit Price (\$)_____per 100 linear feet
1. Description: 100 linear feet of 1” PVC Class 200 pipe, 2 rotary spray heads, 2 pop up heads and any associated valves, heads, cements and fittings to provide water supply to landscaped areas.
 2. Unit of Measurement: per 100 Linear Feet.

- Unit Price No. 10:** Emergency Responder Radio System
1. Description: Provide Emergency Responder Radio System (ERRS). See Detail 5/E604 Emergency Responder System Boosting Riser and Specification Section 27 53 19. Room where panel is located shall be 2 hour rated, and access door/frame shall also be 2 hour rated.
 2. System surveys to determine strength of available signal at the site are part of the Base Bid.
 3. Unit of Measurement: One System as specified.

The bidder further proposes and agrees hereby to commence work under this contract on a date to be specified in a written order of the designer and shall fully complete all work thereunder within the time specified in the Supplementary General Conditions Article 23. Applicable liquidated damages amount is also stated in the Supplementary General Conditions Article 23.

MINORITY BUSINESS PARTICIPATION REQUIREMENTS

Provide with the bid - Under GS 143-128.2(c) the undersigned bidder shall identify **on its bid** (Identification of Minority Business Participation Form) the minority businesses that it will use on the project with the total dollar value of the bids that will be performed by the minority businesses. **Also** list the good faith efforts (Affidavit **A**) made to solicit minority participation in the bid effort.

NOTE: A contractor that performs all of the work with its own workforce may submit an Affidavit (**B**) to that effect in lieu of Affidavit (**A**) required above. The MB Participation Form must still be submitted even if there is zero participation.

After the bid opening - The Owner will consider all bids and alternates and determine the lowest responsible, responsive bidder. Upon notification of being the apparent low bidder, the bidder shall then file within 72 hours of the notification of being the apparent lowest bidder, the following:

An Affidavit (**C**) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the 10% goal established. This affidavit shall give rise to the presumption that the bidder has made the required good faith effort and Affidavit **D** is not necessary;

*** OR ***

If less than the 10% goal, Affidavit (**D**) of its good faith effort to meet the goal shall be provided. The document must include evidence of all good faith efforts that were implemented, including any advertisements, solicitations and other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract.

Note: Bidders must always submit **with their bid** the Identification of Minority Business Participation Form listing all MB contractors, vendors and suppliers that will be used. If there is no MB participation, then enter none or zero on the form. Affidavit **A** or Affidavit **B**, as applicable, also must be submitted with the bid. Failure to file a required affidavit or documentation with the bid or after being notified apparent low bidder is grounds for rejection of the bid.

Proposal Signature Page

The undersigned further agrees that in the case of failure on his part to execute the said contract and the bonds within ten (10) consecutive calendar days after being given written notice of the award of contract, the certified check, cash or bid bond accompanying this bid shall be paid into the funds of the owner's account set aside for the project, as liquidated damages for such failure; otherwise the certified check, cash or bid bond accompanying this proposal shall be returned to the undersigned.

Respectfully submitted this day of _____

(Name of firm or corporation making bid)

WITNESS:

(Proprietorship or Partnership)

By: _____
Signature

Name: _____
Print or type

Title _____
(Owner/Partner/Pres./V.Pres)

Address _____

ATTEST:

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

License No. _____

Federal I.D. No. _____

Email Address: _____

(CORPORATE SEAL)

Addendum received and used in computing bid:

Addendum No. 1 _____ Addendum No. 3 _____ Addendum No. 5 _____ Addendum No. 6 _____

Addendum No. 2 _____ Addendum No. 4 _____ Addendum No. 6 _____ Addendum No. 7 _____

State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of _____

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- 1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- 2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- 3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- 4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- 5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- 6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- 7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- 8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- 9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- 10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

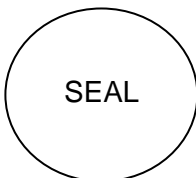
The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract with Own Workforce.

County of _____

Affidavit of _____

(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____

_____ contract.

(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

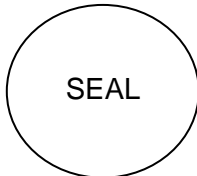
The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement. The Bidder agrees to make a Good Faith Effort to utilize minority suppliers where possible.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20__

Notary Public _____

My commission expires _____

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by HUB Certified/Minority Businesses

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by HUB certified/minority businesses as defined in GS143-128.2(g) and 128.4(a),(b),(e) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit.
 This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the _____
 (Name of Bidder)

_____ (Project Name)
 Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. Attach additional sheets if required

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

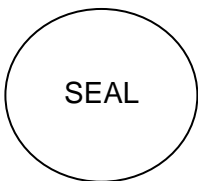
*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____



Signature: _____

Title: _____

State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by HUB Certified/ minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the _____
(Name of Bidder)

Project ID# _____ (Project Name) Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with HUB certified/ minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. (Attach additional sheets if required)

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Examples of documentation that may be required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

- A. Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.
- B. Copies of quotes or responses received from each firm responding to the solicitation.
- C. A telephone log of follow-up calls to each firm sent a solicitation.
- D. For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.
- E. Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.
- F. Copy of pre-bid roster
- G. Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.
- H. Letter detailing reasons for rejection of minority business due to lack of qualification.
- I. Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

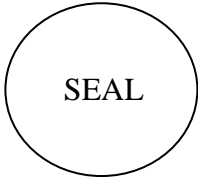
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

AFFIDAVIT E

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

SCO Project ID: _____

Pay Application #: _____ Period: _____

The following is a list of payments made to Minority Business Enterprises on this project for the above-mentioned period.

MBE FIRM NAME	* TYPE OF MBE	AMOUNT PAID THIS MONTH (With This Pay App)	TOTAL PAYMENTS TO DATE	TOTAL AMOUNT COMMITTED

*Minority categories: Black (B), Hispanic (H), Asian American (AA), American Indian (AI), White Female (WF), Socially and Economically Disadvantaged (SED)

Approved/Certified By:

Name

Title

Date

Signature

SUBMIT WITH EACH PAY REQUEST - FINAL PAYMENT - FINAL REPORT

FORM OF BID BOND

KNOW ALL MEN BY THESE PRESENTS THAT _____

_____ as principal, and _____, as surety, who is duly licensed to act as surety in North Carolina, are held and firmly bound unto

Trustees of Richmond Community College

_____ as obligee, in the penal sum of _____ DOLLARS, lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents. Signed, sealed and dated this ____ day of ____ 20__ WHEREAS, the said principal is herewith submitting proposal for and the principal desires to file this bid bond in lieu of making the cash deposit as required by G.S. 143-129.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION is such, that if the principal shall be awarded the contract for which the bid is submitted and shall execute the contract and give bond for the faithful performance thereof within ten days after the award of same to the principal, then this obligation shall be null and void; but if the principal fails to so execute such contract and give performance bond as required by G.S. 143-129, the surety shall, upon demand, forthwith pay to the obligee the amount set forth in the first paragraph hereof. Provided further, that the bid may be withdrawn as provided by G.S. 143-129.1

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

Construction Contract Document Checklist

(For State Projects)

See Section 405 of "North Carolina Construction Manual".

Use this checklist to check contracts **BEFORE submitting** to The State Construction Office for approval.

If you have questions call (919)807-4100.

General:

- Must use State form.
- Contracts must be properly collated per Section 405.10A of the Construction Manual.

Construction Contract:

Page one:

- Date at top should be on or after date of award letter.
- Name of contractor (Party of the First Part) must be the same in all places on contract and bonds.
- Owner's name (Party of the Second Part) must be correct and the same in all places on contract and bond forms.
- Project description must be accurate.
- State Construction Office Project ID Number must be on first page of contract.

Page two:

- Amount must be correct and match award letter.
- Words and numbers must match.
- "Summary of Contract award:" must be filled in correctly.

For Example:	Base Bid	\$650,000
	Alternate G-1(single ply roof)	9,500
	Less Negotiations (see attachment)	<u>(8,000)</u>
	Total	\$651,500

Page three:

- Number of counterparts must be filled in (at least four - coordinate with Owner).
- Name of Contractor must match first page.
- Signatures:

Corporation:

- MUST be signed by PRESIDENT or VICE PRESIDENT and attested by corporate secretary or assistant secretary. These two signatures must be by two different people.
- The two signatures must be by two different people.
- Must have corporate seal.
- Name on corporate seal must match name on contract.
- Same person must sign contracts and bonds.

Non-corporation:

- Must be signed by Owner or Partner.
- Must be witnessed.
- Same person must sign contracts and bonds.
- Name of Owner must match first page.
- Owner must sign contract and have signature witnessed.
- Any Negotiations or attachments must be attached.

Performance and Payment Bonds:

- MUST USE STATE BOND FORMS** No Exceptions - No Additions - No Riders..
AIA Bond Form is NOT Acceptable. See Article 35, "General Conditions of the Contract"

Page one:

- "Date of Contract" must match date on page one of the contract.
- "Date of Execution" must be on or after "Date of Contract".
- "Name of Principal" (Contractor) must match name on contract.
- "Name of Surety" must be the same on page one and two and must match the Power of Attorney.
- Address of Surety must be shown
- "Name of Contracting Body" (owner) must match name of owner on contract.
- "Amount of Bond" must be 100% of the construction contract amount.
- Words and numbers must match.
- "Project" must match project name on contract.

Page two:

- Number of counterparts must match page three of the contract.
- Name of Contractor must match page one.
- Signatures:
 - Corporation:
 - MUST be signed by PRESIDENT or VICE PRESIDENT and attested by corporate secretary or assistant secretary. These two signatures must be by two different people.
 - Must have corporate seal.
 - Same person must sign contracts and bonds.
 - Non-corporation:
 - Must be signed by Owner or Partner.
 - Must be witnessed.
 - Same person must sign contracts and bonds.
- Name of Surety must match page one.
- Attorney-in-Fact must sign and have signature witnessed.
- Must have Surety's corporate seal.
- Must show Bonding Company address.
- If the Attorney-in-Fact is not a resident of North Carolina, then the bonds must be countersigned by a North Carolina RESIDENT agent of the bonding company and his address must be shown on the form.

Power of Attorney sheet:

- This is the sheet that comes from the Bonding Agent and is attached behind the bonds.
- Attorney-in-Fact must appear on this sheet.
- Monetary limit of the Attorney-in-fact must be at least as much as the bond amount.
- The bottom of most Power of Attorney sheets has a place for a date and seal - these must be filled in.
- The certification date (usually at the bottom of the page) of the Power of Attorney must be on or after the "Date of Execution" on page one of the bonds.

Insurance Certificate:

- See Article 34, "General Conditions of the Contract".
- Must show General Liability and Worker's Compensation insurance.
- Must show Builder's Risk or Installation Floater insurance of 100% of the construction contract amount.
- Cancellation clause must be as shown in Article 34 of the "General Conditions" (see attached instructions for correction).
- "Certificate Holder" must be The Owner and project description must be correct.

The insurance certificate(s) in the formal Contract do(es) not indicate cancellation notification provisions in accordance with Contract General Conditions Article 34 are included in the insurance policy contract(s). The insurance policy contract(s) must contain cancellation provisions in accordance with this formal Contract Article. Since modification to the insurance certificate form is no longer accepted, this issue may be corrected in the following way:

a) Verify that the insurance policy contract(s) include(s) the required cancellation provision.

-----and either b) or c) below-----

b) Provide insurance certificate(s) to this office with language appropriately inserted in the insurance certificate block provided for Special Provisions, as follows: "Notwithstanding the preprinted cancellation provisions on this form, coverages afforded under the policies will not be cancelled, reduced in amount nor will any coverages be eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the owner, of such alteration or cancellation."

[This language can be continued on an attached and properly titled continuation sheet as long as the first clause ("Notwithstanding....form,") is on the face of the form]

-----or if space will not allow b), at a minimum -----

c) Insert at a minimum in the block for Special Provisions, "Cancellation and notice provisions on the attached endorsements control over language on this form." Then attach the required language provided in b) above.

FORM OF CONSTRUCTION CONTRACT

(ALL PRIME CONTRACTS)

THIS AGREEMENT, made the _____ day of _____ in the year of 20__ by and between _____

_____ hereinafter called the Party of the First Part and Trustees of Richmond Community College hereinafter called the Party of the Second Part .

WITNESSETH :

That the Party of the First Part and the Party of the Second Part for the consideration herein named agree as follows:

1. Scope of Work: The Party of the First Part shall furnish and deliver all of the materials, and perform all of the work in the manner and form as provided by the following enumerated plans, specifications and documents, which are attached hereto and made a part thereof as if fully contained herein: advertisement; Instructions to Bidders; General Conditions; Supplementary General Conditions; specifications; accepted proposal; contract; performance bond; payment bond; power of attorney; workmen's compensation; public liability; property damage and builder's risk insurance certificates; approval of attorney general; certificate by the Office of State Budget and Management, and drawings, titled:

Consisting of the following sheets: _____

Dated : _____ and the following addenda:

Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____
Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____
Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____
Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____

2. That the Party of the First Part shall commence work to be performed under this agreement on a date to be specified in a written order of the Party of the Second Part and shall fully complete all work hereunder within _____ consecutive calendar days from said date. For each day in excess thereof, liquidated damages shall be as stated in Supplementary General Conditions. The Party of the First Part, as one of the considerations for the awarding of this contract, shall furnish to the Party of the Second Part a construction schedule setting forth planned progress of the project broken down by the various divisions or part of the work and by calendar days. If the Party of the First Part

fails to begin the work under the contract within the time specified, or the progress of the work is not maintained on schedule, or the work is not completed within the time above specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the Party of the First Part shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the Party of the Second Part may give notice in writing, sent by certified mail, return receipt requested, to the Party of the First Part and his surety of such delay, neglect or default, specifying the same, and if the Party of the First Part within a period of fifteen (15) days after such notice shall not proceed in accordance therewith, then the Party of the Second Part shall, declare this contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this contract in the manner and within the time frame specified. In the event the surety shall fail to take over the work to be done under this contract within fifteen (15) days after being so notified and notify the Party of the Second Part in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the Party of the Second Part shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said Party of the First Part, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said contract according to the terms and provisions thereof or use such other methods as in his opinion shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the Party of the Second Part, together with the costs of completing the work under contract, shall be deducted from any monies due or which may become due said Party of the First Part and surety. In case the expense so incurred by the Party of the Second Part shall be less than the sum which would have been payable under the contract, if it had been completed by said Party of the First Part, then the said Party of the First Part and surety shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the Party of the First Part and the surety shall be liable and shall pay to the Party of the Second Part the amount of said excess.

3. The Party of the Second Part hereby agrees to pay to the Party of the First Part for the faithful performance of this agreement, subject to additions and deductions as provided in the specifications or proposal, in lawful money of the United States as follows:

(\$ _____) .

Summary of Contract Award:

4. On or before the 20th day of each calendar month, the Party of the Second Part shall make payments to the Party of the First Part on the basis of a duly certified and approved estimate of work performed during the preceding calendar month by the First Party, less five percent (5%) of the amount of such estimate which is to be retained by the Second Party until all work has been performed strictly in accordance with this agreement and until such work has been accepted by the Second Party. The Second Party may elect to waive retainage requirements after 50 percent of the work has been satisfactorily completed on schedule as referred to in Article 31 of the General Conditions.

5. Upon submission by the First Party of evidence satisfactory to the Second Party that all payrolls, material bills and other costs incurred by the First Party in connection with the construction of the work have been paid in full, final payment on account of this agreement shall be made within thirty (30) days after the completion by the First Party of all work covered by this agreement and the acceptance of such work by the Second Party.

6. It is further mutually agreed between the parties hereto that if at any time after the execution of this agreement and the surety bonds hereto attached for its faithful performance, the Second Party shall deem the surety or sureties upon such bonds to be unsatisfactory, or if, for any reason, such bonds cease to be adequate to cover the performance of the work, the First Party shall, at its expense, within five (5) days after the receipt of notice from the Second Party so to do, furnish an additional bond or bonds in such form and amount, and with such surety or sureties as shall be satisfactory to the Second Party. In such event no further payment to the First Party shall be deemed to be due under this agreement until such new or additional security for the faithful performance of the work shall be furnished in manner and form satisfactory to the Second Party.

IN WITNESS WHEREOF, the Parties hereto have executed this agreement on the day and date first above written in _____ counterparts, each of which shall without proof or accounting for other counterparts, be deemed an original contract.

Witness:

Contractor: (Trade or Corporate Name)

(Proprietorship or Partnership)

By: _____

Title: _____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

Trustees of Richmond Community College

(CORPORATE SEAL)

(Agency, Department or Institution)

Witness:

By: _____

Title: _____

FORM OF PERFORMANCE BOND

Date of Contract: _____

Date of Execution: _____

Name of Principal
(Contractor) _____

Name of Surety : _____

Name of Contracting
Body : _____

Amount of Bond : _____

Project

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind, ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body, identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the contracting body, with or without notice to the surety, and during the life of any guaranty required under the contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, 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.

Executed in _____ counterparts .

Witness :

(Proprietorship or Partnership)

Attest: (Corporation)

By: _____

Title : _____
(Corp. Sec. or Asst. Sec.. only)

(Corporate Seal)

Contractor: (Trade or Corporate Name)

By: _____

Title : _____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

(Surety Company)

Witness :

By: _____

Title : _____
(Attorney in Fact)

Countersigned :

(Surety Corporate Seal)

(N.C. Licensed Resident Agent)

Name and Address-Surety Agency

Surety Company Name and N.C.
Regional or Branch Office Address

FORM OF PAYMENT BOND

Date of Contract: _____
Date of Execution: _____
Name of Principal
(Contractor) _____
Name of Surety : _____
Name of Contracting
Body : _____
Amount of Bond : _____
Project _____

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall promptly make payment to all persons supplying labor/material in the prosecution of the work provided for in said contract, and any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, 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.

Executed in _____ counterparts .

Witness :

(Proprietorship or Partnership)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec.. only)

(Corporate Seal)

Contractor: (Trade or Corporate Name)

By: _____

Title: _____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

(Surety Company)

Witness :

By: _____

Title: _____
(Attorney in Fact)

Countersigned :

(Surety Corporate Seal)

(N.C. Licensed Resident Agent)

Name and Address-Surety Agency

Surety Company Name and N.C.
Regional or Branch Office Address

Sheet for Attaching Power of Attorney

Sheet for Attaching Insurance Certificates

APPROVAL OF THE ATTORNEY GENERAL

**CERTIFICATION BY THE OFFICE OF STATE
BUDGET AND MANAGEMENT**

Provision for the payment of money to fall due and payable by the

under this agreement has been provided for by allocation made and is available for the purpose of carrying out this agreement.

This _____ day of _____ 20____.

Signed _____
Budget Officer